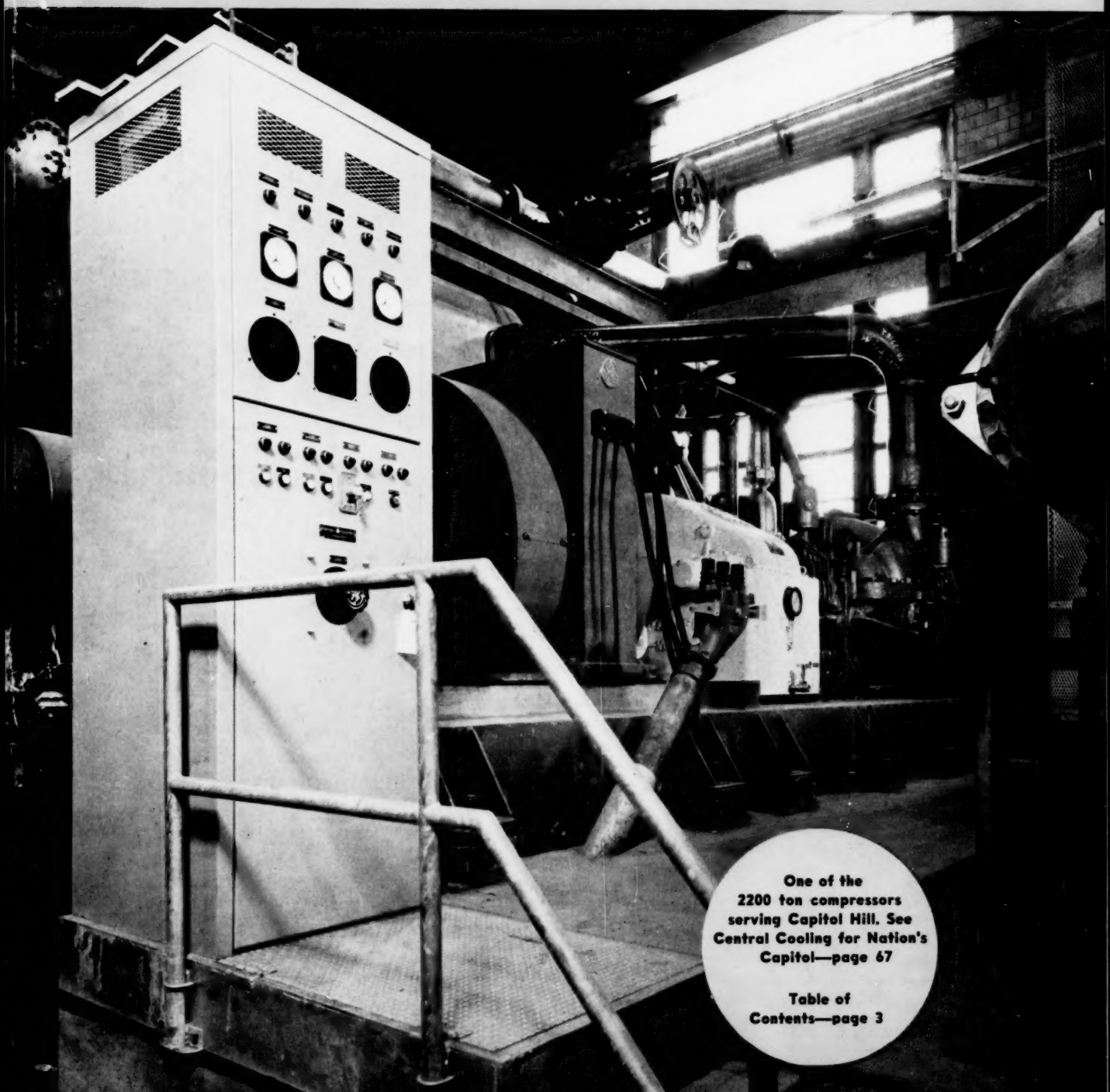
AIR CONDITIONING HEATING AND VENTILATING

JUNE, 1956 – 53rd YEAR



One of the 2200 ton compressors serving Capitol Hill. See Central Cooling for Nation's Capitol—page 67

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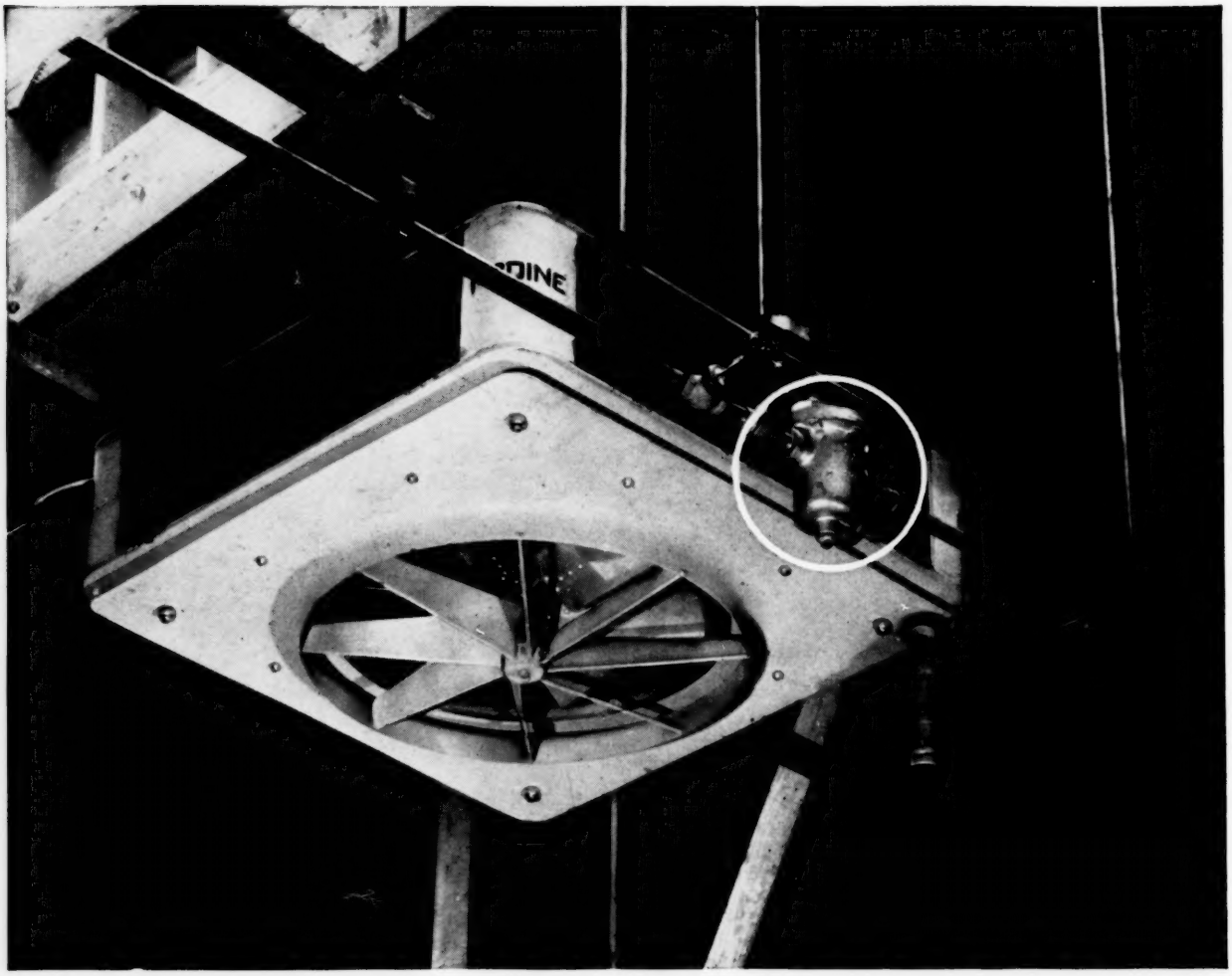
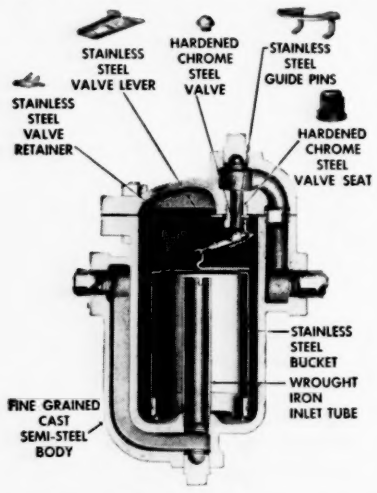


How Corrosion of Unit Heaters is Prevented by Good Trapping


STAINLESS STEEL VALVE LEVER
HARDENED CHROME STEEL VALVE
STAINLESS STEEL GUIDE PINS
STAINLESS STEEL VALVE RETAINER
HARDENED CHROME STEEL VALVE SEAT
STAINLESS STEEL BUCKET
WROUGHT IRON INLET TUBE
FINE GRAINED CAST SEMI-STEEL BODY

Good Traps. The mechanisms in Armstrong traps for unit heaters are substantially identical in design, workmanship and materials to those used in traps for 900 lbs. pressure, 900 degrees F.

Cause. Costly corrosion of unit heaters is frequently the result of sluggish condensate drainage and inadequate venting. Any carbon dioxide gas present in the steam supply will go into solution if the condensate is below steam temperature, forming corrosive carbonic acid. Presence of oxygen aggravates the corrosion.

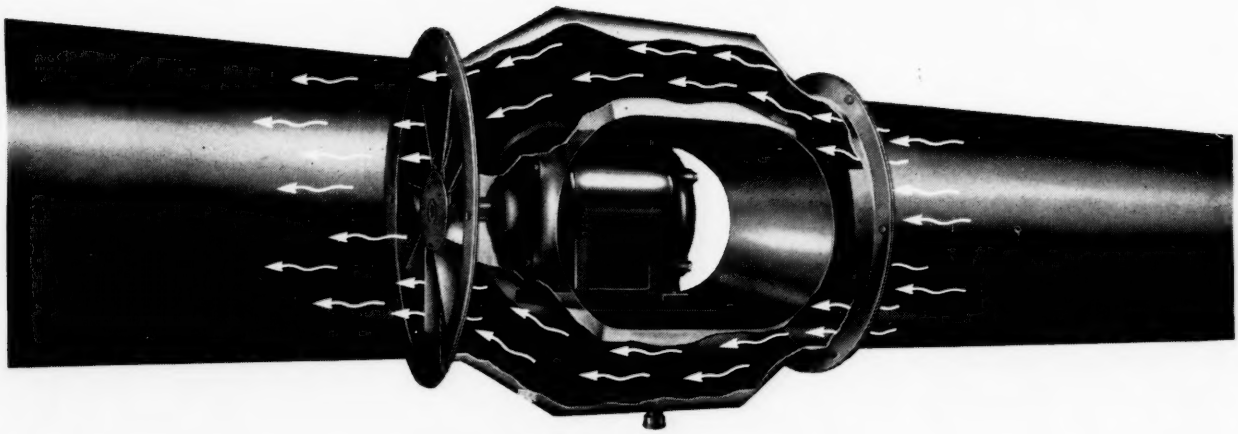
Remedy. Armstrong traps prevent carbonic acid formation because they discharge condensate *at steam temperature* and vent CO_2 and air at the same time. There is never any accumulation of condensate and incondensible gases to cause trouble as can occur with traps that must wait for condensate to cool before they will open.

Trap Selection. It is important that the traps be correctly sized, with a generous safety factor to provide adequate air handling capacity. Armstrong sizing recommedations are thoroughly reliable, being based on actual performance of the traps under operating conditions rather than on theoretical considerations.

Complete Details. Ask for Armstrong Bulletin No. 2312 which tells how to select and install traps for any type of unit heater. For your free copy, call your local Armstrong Factory Representative, or write:

ARMSTRONG MACHINE WORKS
846 Maple Street, Three Rivers, Michigan

ARMSTRONG STEAM TRAPS *Application Engineered*



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You pay nothing extra for DeBothezat's 30 years' experience in solving corrosive fume problems. DeBothezat know-how is the reason for the designed-in efficiency of this split-housing fan — and for the competent assistance you get in *applying* this fan to your specific fume-removal problem. You can specify a DeBothezat Bifurcator . . . install it . . . forget it. It will be right for your job. It needs no attention besides an occasional routine check-up. It runs day in and day out, trouble free.

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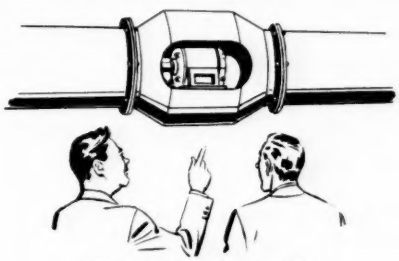

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A DIVISION OF
American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS

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American Machine and Metals, Inc.
East Moline, Illinois

☐ Send Bulletin DB-37-55 containing complete data on the Bifurcator for exhausting corrosive fumes.

☐ Have a DeBothezat representative call.

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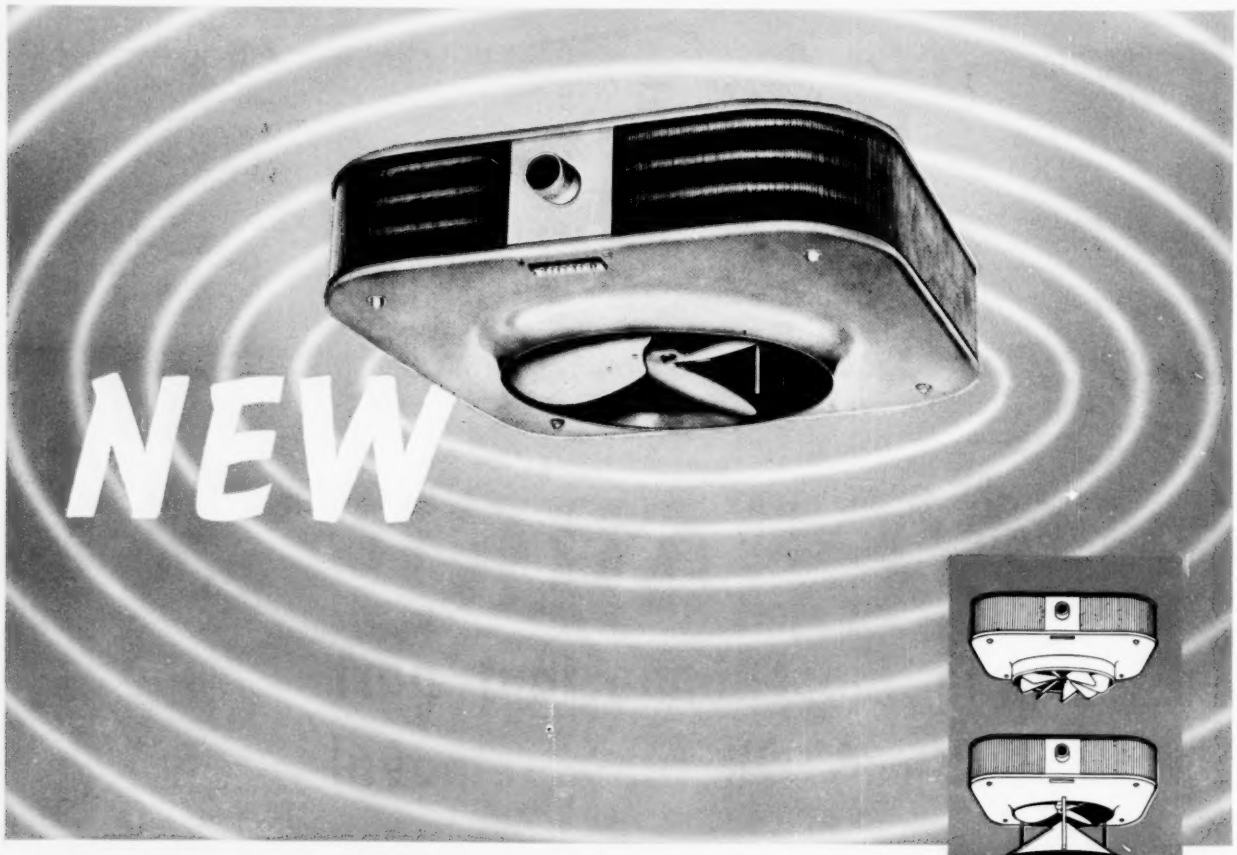
CITY _____ ZONE _____ STATE _____

ATTENTION MR. _____



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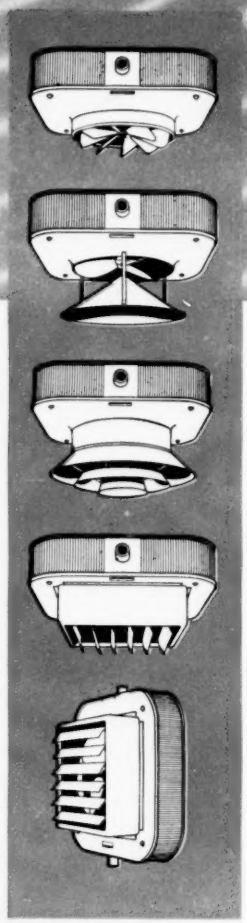
- ▶ Horizontal discharge units, too
- ▶ IUHA-rated for capacity and sound

Call your Webster Representative for the new 20-page Bulletin B-1730. Or write us. Address Dept. HV-6.

WARREN WEBSTER & COMPANY
Camden, New Jersey



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HEATING AND COOLING
EQUIPMENT

AIR CONDITIONING HEATING AND VENTILATING

JUNE, 1956

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The Cover: One of the new 2200-ton refrigeration units in the new central air conditioning system serving public buildings on Capitol Hill, Washington, D. C. Photo by Harry L. Burnett, Jr. System described beginning page 67.

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Feeds water to boiler at 12 lbs. — Pressure relief at 30 lbs.

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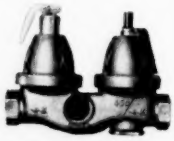
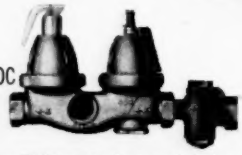
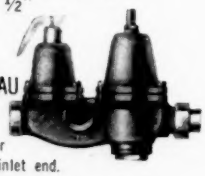


N450 Popular design Size ½"



N450C

Nos. N450C or 45AC have check valve and strainer



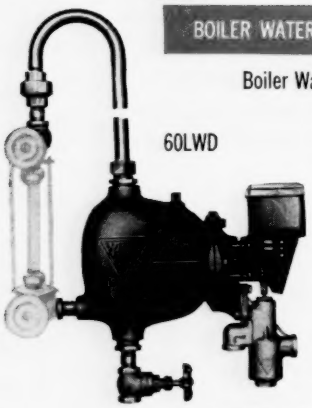
45AU

Nos. 45AU or N450U have sweat copper union applied to inlet end.

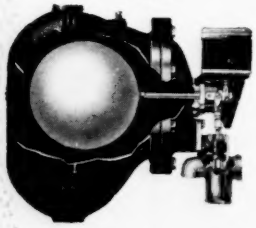
BOILER WATER LEVEL CONTROLS FOR LOW PRESSURE STEAM HEATING BOILERS

Boiler Water Feeders

60LWD



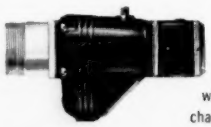
76LWD



Feeder cut-off combinations

Low Water Cut-Offs

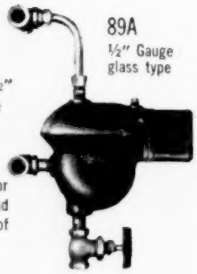
Maximum steam pressure 25 lbs.



101A Exclusive 2½" screw-in type with sediment chamber.

193A 2½" Screw-in type for use where shallow section and depth of jacket prevent use of No. 93A.

89A ½" Gauge glass type



93A 2½" screw-in type

50A 1" Float chamber connections for use on process boilers and hot water heating boilers. Max. steam press. 50 lbs.

SERIES	CONNECTIONS	CAPACITY	STEAM	WATER
60	½" gauge glass	up to 5,000 sq. ft. rad.	25 lbs.	150 lbs.
76	1" chamber, ¾" feed valve	over 5,000 sq. ft. rad.	35 lbs.	150 lbs.
81	1" chamber, ¾" feed valve	over 5,000 sq. ft. rad.	35 to 75 lbs.	150 lbs.

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FOLDER F-60

Boiler water level controls for heating and process steam boilers

WATTS REGULATOR COMPANY

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LARGEST AND MOST COMPLETE LINE OF ITS KIND IN THE WORLD

HIGH SPOTS

• Pilot experiments costing over $2 million show that Britain may be able to generate electricity at less cost by **burning coal underground** than by mining it and transporting it to power stations. Six years of underground gasification trials in the English Midlands have demonstrated savings of 20 to 50%.

• The U. S. Air Force will build a **large solar furnace** in the Sacramento Mountains near Alamagorda, N. M. The furnace will be a system of focusing mirrors capable of concentrating solar heat to 7,000 to 8,000 deg. F over a larger area than any similar device and will be used for high temperature research.

• **Total underground storage of natural gas** passed the two-trillion cubic feet mark in 1955, according to AGA. Facilities for underground storage represent a total investment of about $377 million, including physical properties and cushion gas.

• In the shriveled plains about New Delhi, India, the temperature has been **about 115 deg. F** for most of May, and the fierce sun drives most people indoors and limits travel to the hours after sundown. Government officials say office working efficiencies dropped 50%. Foreigners spend most of their time huddled up to air conditioners wondering how the people take it.

• Six executives of Crane Co. and two crew members were killed on May 15 when a company plane crashed in Indiana. See page 142.

• **A new heat pump design** with two stages of compression on the heating cycle permits use of low temperature air as a heat source in northern winters. See page 146.

• In Maryland's **preserved colonial mansions,** visitors are surprised by their interior coolness on hot, humid days. By accident, if not by design, according to a report by Harriet Crittenden, **air-conditioning** of a sort resulted from the following methods of pioneer artisans who built the houses: Interior facings of the houses were made of salmon colored bricks. Sawdust was mixed with the clay and the sawdust was burned out during the firing, leaving porous salmon bricks. Being porous, the salmon bricks absorbed moisture. Air space was also left in houses between inner and outer walls for insulation. Houses also had large chimneys and lacked dampers to control drafts.

• Data on the **effect of awnings on air conditioning load** will be compiled in a cooperative research program planned at ASHAE Research Laboratory in Cleveland using contributions of the National Metal Awning Association, the Canvas Awning Institute, and the National Canvas Goods Manufacturers Association. Another ASHAE project now in work is a study of the effect of air conditioning on human comfort and performance. The current $240,000 research program of the Society includes 22 projects at the Cleveland Laboratory and in 11 cooperating institutions.

• A permit has been issued to MIT for construction of a **research reactor** which will be heavy-water cooled and moderated, enclosed in a gas-tight, steel-shell building on the MIT campus in Cambridge, Mass., for use in medical therapy and research.

• Use of hydrogen in oil refining should have a tremendously beneficial effect on **heating oil quality** in the next few years, W. A. Sullivan of Shell Oil Co. told an API mid-year meeting. Hydrogen for use in a process that greatly increases the stability of heating oils is now available as a by-product from new catalytic reforming units which have been added to refineries to improve gasoline quality.

• Contract awards for future construction in the 37 eastern states set an **all-time record for April,** according to Dodge reports, and were the second highest contract figure for any month in Dodge history. A new first-four-month record was also established 13% greater than that of the 1955 period.

• The greatest market for the **expansion of air conditioning** lies in the nation's industrial plants where present penetration is less than one percent, John E. Haines of Minneapolis-Honeywell told a Kansas State College seminar. Factors of competition make it inevitable that a very large percentage of production facilities will be air conditioned within a few years, Mr. Haines said.

WASHINGTON OVERTONES

by LORING OVERMAN

Washington's mid-May overtones stemmed primarily from the city's official preoccupation with politics.

While not a new development, this time the **poltical influence seems a little more apparent than usual.**

Factors:

- July 1 is the adjournment target for Congress; July 15 is the probable deadline.

Between now and closing day, members of Congress, perhaps like school boys, will want to **do no more than is absolutely necessary,** yet to receive a report card carrying enough A's to call for re-election.

Consequently, **controversial legislation** has little chance of passage. Among projects within that category:

- **School construction seems stymied** by the segregation question.
- **Taft-Hartley** Act sentiment widely divided.
- **Higher mail rates** could pass if limited only to commercial users; probably not if individual letter postage is increased.
- **Anti-lobbying laws** hearings still under way.
- **Disaster insurance** and aid for distressed areas, most unlikely.

Considered likely to pass:

At top of the list place the **1957 budget** . . . nearly $66 billion . . . $33.6 billion for **national defense.** Included: $16 billion for Air Force, $10 billion for Navy; $7.5 billion for Army.

- Virtually assured: **highway legislation** increasing taxes on gasoline and tires to pay for 40,000-mile expansion over next 10 years.

- On the way: a **housing law** to increase FHA mortgage authorization to $3 billion; liberalize FHA home repair loans, and include a special housing program for elderly people. Subject to Senate acceptance and House concurrence, the Senate Banking Committee has voted to approve a new omnibus housing bill which would authorize more than 500,000 public housing units at the rate of 135,000 a year. The Administration has asked for only 35,000 units, for two years.

- Sure to be extended: the **Defense Production Act,** including power to allocate scarce materials, and to renegotiate defense contracts.

On the doubtful list are proposals to **trim income taxes.** Both Republicans and Democrats would like to receive credit for such a tax cut . . . so chances are both will hang onto the ball until the adjournment whistle blows.

- Meanwhile, Representative Reed (R-N. Y.), ranking minority member of the House Ways and Means Committee, has asked the Joint Committee on Internal Revenue Taxation to study his plan for a reduction of individual income taxes "when the budget permits."

Reed suggested the study be made at once, but he presented no evidence that a tax reduction would be possible in the immediate future. He proposed that the top bracket rate, now 91%, be reduced to at least 75%, and that rates for other brackets, including the bottom 20%, be adjusted downward to conform to the new top rate.

Another topic providing much political ammunition is the proposal to **expand coverage of the Social Security Act** and to increase certain payments to beneficiaries. As a program designed to interest many voters, its provisions may be expected to seesaw between now and the final vote—probably without passing in the actual showdown.

- At press time for this column, the Senate Finance Committee had tightened materially the House-passed Social Security Bill, H.R. 7225. Senate committeemen rejected a pro-

(Continued on page 8)

THIS "Poison gas"...

COMMON IN HOUSEHOLDS, IS DEADLY TO BUILDINGS!

Huge quantities of a dangerous, invisible gas are generated by the normal daily household activities of an average American family of four; enough to condense into 76 quarts of a destructive liquid each week.

The soil under a building, especially in a crawl space, may also give up this gas at the rate of 336 quarts per week per 1000 sq. ft., when liquefied.

If this gas turns into liquid *inside* building spaces, it will foster the ROTTING of Wood, the CRUMBLING of Plaster, the PEELING of Paint, the RUST and CORROSION of Metal, even the BREAKING-DOWN of Brick, Concrete and Mortar.

This gas can also be a THIEF OF HEAT and FUEL in winter, as well as a destroyer of the building. With each pound of it that flows out of a building, there is an actual loss of 1060 Btu's of latent heat.

THERE IS A PREVENTIVE!

Aluminum has almost zero permeability to all gases, including the destructive gas of water, known as "vapor." Large quantities of vapor flow into ceiling and wall spaces, unless its path is barred. Condensation formation on or within scientific multiple aluminum insulation is minimized by the construction of multiple layers of aluminum, fiber and air spaces. Installation of this pre-fabricated material is easy. The aluminum sheets stretch with uniform depth from joist to joist*, and are a continuous vapor-barrier up to 750 ft. long, without breaks every few feet. Vapor infiltration under the flat stapled flanges is slight.

*Patent applied for

The heat ray reflectivity of its aluminum surfaces is 97%; absorptivity and emissivity are only 3%. This is important because the flow of heat rays, or RADIATION, constitutes 50% to 93% of heat flow through building spaces (depending on direction). The multiple layers of aluminum and fiber retard CONVECTION, while CONDUCTION is slight through the low density, multiple air spaces.

National Bureau of Standards tests were made under various extreme wintry conditions with quantities of vapor, to find if condensation would form in air spaces where reflective insulation was installed below a wood floor over a crawl space. The results are reported in an interesting and informative booklet of the National Housing Agency, "Technical Bulletin #38." Just use the coupon to get a copy FREE.

INFRA INSULATIONS CAN BE PURCHASED everywhere through your preferred local dealer for 3¢ to 12¢ per sq. ft. depending on the type.

Infra Insulation, Inc., 525 Bway., N.Y.C., Dept V-6

Please send NHA's "Technical Bulletin No. 38."

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ADDRESS

WASHINGTON OVERTONES (*Continued from page 6*)

posal to lower the retirement age for women to 62 from 65. Senate version O.K.'d the lower age for widows. The Senate committee also rejected a House-proposed increase of 25% in the Social Security tax, to cover the additional benefits.

Because the subject of taxes is so politically sensitive, business organziations are urging their members to inform Members of Congress of their views while tax changes are under consideration.

Of extreme importance to members of the air-conditioning, plumbing and heating professions is the housing market's reaction to Washington's **manipulation of mortgage credit.** Federal Reserve Board has passed the word that mortgage funds must be kept in check as a hedge against inflation.

● Federal Housing Administration officials, on the other hand, report that the credit checkrein is already drawn so tight that the housing program is **bogging down.** Housing starts through April were at the annual rate of 1,140,000 . . . not the 1,300,000 predicted early this year by the National Housing Administrator. Some builders are observing that GI applications have dwindled to nothing, and that only the generals and colonels are in a position to buy at current prices and interest rates.

● Predicted for the balance of the year . . . unless credit eases . . . is a trend toward **larger and more completely equipped homes** of the type only the more prosperous can afford. This, in turn, signals air conditioning and more and better plumbing installations.

● Also of interest to the purveyors of larger equipment is the Administration's request for another $100 million to be added to an existing half million dollar revolving fund for **college housing.** Request is backed up by an estimate that colleges will need approximately $2 billion for housing over the next decade.

● Another outlet for multi-unit heating and air conditioning equipment would result from the special program of **housing for the elderly,** proposed in the Administration's omnibus housing bill. The Administration is suggesting insured 95% loans for a period of 39 years and 3 months to non-profit organizations which would build housing for the elderly.

Important to all who specify or furnish equipment employing coal as a fuel are joint recommendations of government and industry which favor immediate expansion of **research in bituminous coal fields.** Purpose: to enable the industry to meet future competition with such new energy sources as oil shale and atomic and solar power.

● Report recommends 209 specific research and market possibilities. It predicts that the nation's total energy requirements will increase nearly two-thirds by 1975. Energy requirements, in bituminous coal equivalent, are expected to rise from the present 1,573 million to 2,530 million tons. If coal maintains its present 30% of the market, requirements in 1975 would reach 759 million tons.

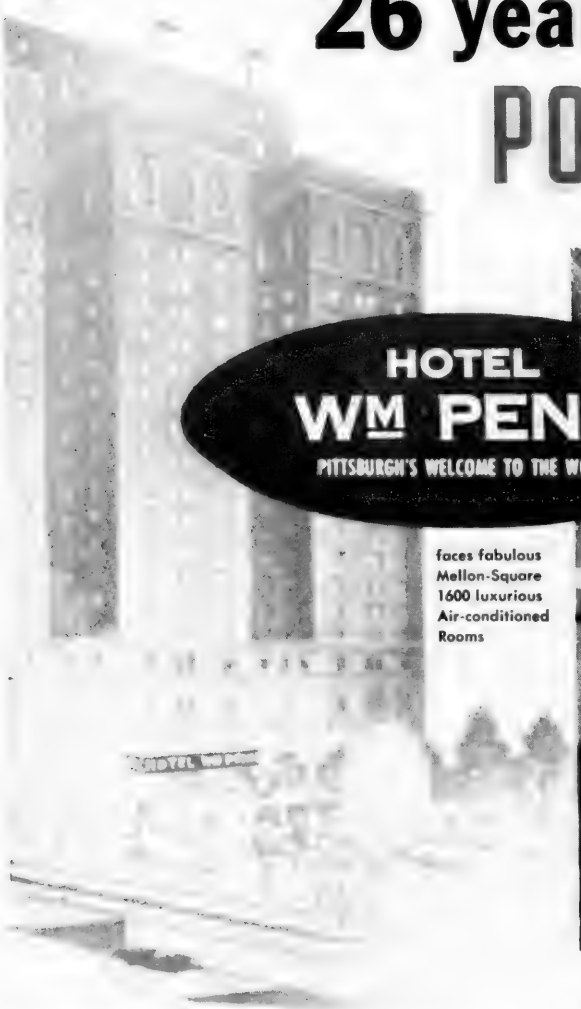
Report points out that there can be a bright future for coal because of its almost limitless reserves. However, real money must be invested in research, the report observes.

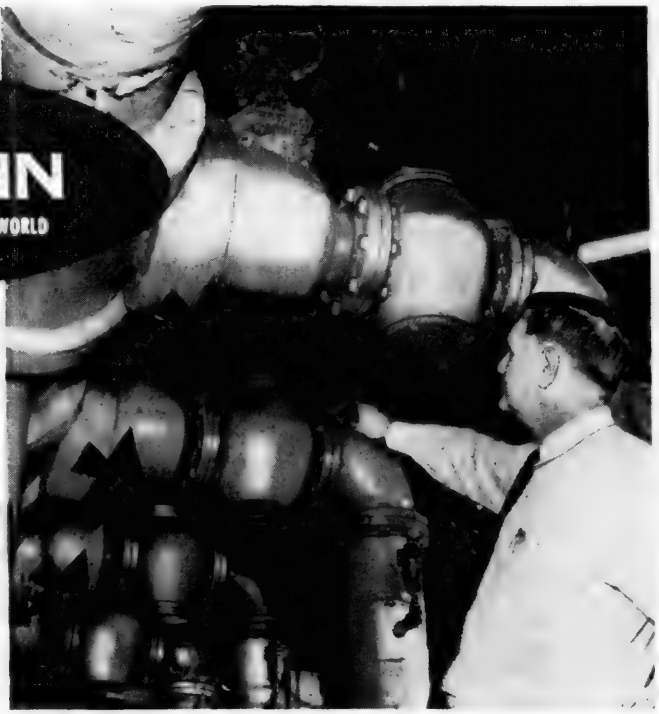
Copy of the report may be obtained from Bureau of Mines, Publication Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. Ask for Information Circular 7754, "Outlook and Research Possibilities for Bituminous Coal."

● One of the first preliminary reports from the 1954 Census of Business concerns **bulk storage facilities** at plants, terminals and wholesale levels for petroleum and LP gas. The report, including breakdowns of storage facilities by states and type of product, is available for 10 cents from the Census Bureau or from Commerce Department field offices.

● Atomic Energy has proposed an extensive program of **goverment insurance and indemnities** to supplement private insurance coverage in the atomic energy field. The Commission's proposals are expressed in a draft of a proposed bill, submitted to the Congressional Joint Atomic Energy Committee. The group opened public hearing on May 14 to consider methods of removing major obstacles to progress in the nuclear power field. A principal obstacle has been inability of participating companies to arrange adequate insurance coverage.

26 year old installation of POWERS No. 11 Self-Operating TEMPERATURE REGULATORS





Each of the four 6" POWERS No. 11 Regulators shown above controls steam supply to a 10,000 gal. water heater. The 4 water heaters provide 140°F. water for use throughout the building.

Often pay back their cost 3 to 6 times a year. By preventing fuel losses caused by OVER-heated water and lasting many years, Powers No. 11 Regulators are a highly profitable investment.

Better temperature control results from their powerful bellows and minimum of valve stem friction. Valve Stem Lubricator aids easy movement of valve stem without binding. Double ply metal used in Powers bellows outlasts ordinary single ply type.

(c69)

POWERS No. 11 Self-Operating TEMPERATURE REGULATORS
Are fully described in Bulletin 329. Write for a copy.

"all are still giving good control"

. . . states Mr. George Volkart, Chief Engineer of Pittsburgh's well known Hotel Wm. Penn. All four of the Powers regulators were installed in 1930. Operating top for one regulator was replaced in 1954. Now (April, 1956) they are still giving the same good control we have had for over a quarter of a century."

Will the temperature regulators you are buying today give performance records like those above? With today's high cost of maintenance, Powers time-proven QUALITY controls are a more profitable investment than ever before.

Right type of Regulator and proper size valve is important for good control. Make sure, call Powers nearest office for help with your problems of temperature control.

THE POWERS REGULATOR COMPANY
SKOKIE, ILLINOIS | *Offices in chief cities in U.S.A., Canada and Mexico*
65 years of Automatic Temperature and Humidity Control

BRIEFLY STATED

• Because of the interest in nuclear energy and how it may affect the heating and air conditioning industry, a Nuclear Energy Engineering Committee has been formed by the American Society of Heating and Air Conditioning Engineers. The chairman of the committee is Ralph A. Sherman, Columbus, Ohio, treasurer of the Society and technical director, Battelle Memorial Institute.

• Copeland Refrigeration Corp., Sidney, Ohio, has appointed Charles Streck factory manager of its compressor manufacturing operations the company announced. Prior to joining Copeland, Mr. Streck, was factory manager of AirCraft Division of Hussmann Refrigerator Co., St. Louis, Mo., and Kupfer Products Co., Madison, Wis.

• A. B. Drastrup has been appointed vice-president of Joy Manufacturing Company, with headquarters at the company's executive offices in Pittsburgh, Pa. Mr. Drastrup formerly was president of A. M. Byers Company. Before being elected president of A. M. Byers Company, Mr. Drastrup was an accountant with the Indiana Steel Company and later held a similar position with the Columbia Steel Company.

• A library devoted exclusively to solar energy is in operation at the headquarters of the Association for Applied Solar Energy in Phoenix, Ariz. The library contains more than 2500 references in the form of technical papers, articles and patents, all dealing with solar energy research and development. Also in the library are the few books which exist on the subject of solar energy.

• John G. Seiler has been elected president of Tube Turns, Louisville, Ky., a division of the National Cylinder Gas Company, Chicago, Ill. Mr. Seiler succeeds George O. Boomer, who is retiring. Mr. Boomer will continue as chairman of the executive committee of the National Cylinder Gas Company.

• The board of directors of C. A. Dunham Co., Chicago, Ill., and The Bush Mfg. Co., West Hartford, Conn., have favorably considered a proposal to consolidate their separate businesses and properties into a new company. Under the proposal, a new Connecticut corporation to be known as Dunham-Bush, Inc. would be formed. Upon completion of the preliminary steps and development of a final program, the plan will be submitted to the stockholders of both companies for approval.

• Albert Kahn Associated Architects and Engineers, Detroit, Mich., have been notified by Factory Management & Maintenance magazine that two plants of their design have been selected as winners in the magazine's 22nd Annual Competition for significant plants of the year. This is the second consecutive year in which two plants designed by the Kahn organization have been so honored. One of the two plants selected is the 800,000 sq ft helicopter plant erected by the Sikorsky Aircraft Division of United Aircraft Corp. on a 250-acre site near Stratford, Conn. The other is the new engine plant recently completed for the Briggs & Stratton Corp. at Wauwatosa, Wis.

• W. E. Hutton-Miller, president of Texas Glass Fiber Corp., Grandview, Tex., announced the appointment of Product Techniques, Inc., Hudson, Ohio, as the company's national sales and engineering representatives. The appointment will give the company centrally located sales and engineering facilities for the marketing of a glass fiber air filter media, for use in disposable type air filters, a parallel fiber mat for reinforced plastic applications, such as corrugated building sheets, and glass fiber pipe wrap. Product Techniques, Inc., will also investigate and develop applications of glass fiber for roofing, wallboard, and insulation.

• Two executive appointments within Carrier Corporation's Unitary Equipment Division were announced by Russell Gray, vice president and general manager of the division. Burton T. Kehoe is appointed assistant to the general manager, reporting to Mr. Gray. Arthur E. Meling is named manager of the division's newly created Weathermaker department which consolidates the residential and self-contained units departments.

• Peter J. Kohler, product design engineer with Modine Mfg. Co., since August, 1950, has been promoted to sales engineer of the company's Industrial Division. Mr. Kohler's previous duties were primarily with the company's heating and air conditioning division. Before joining Modine, he worked for Kalamazoo Stove and Furnace Co. and Western Electric Co. as a product engineer.

• The Fluid Controls Institute, formerly the National Steam Specialty Club, has announced the adoption of a standard classification and terminology system for power-actuated valves. The project was undertaken by the Institute to provide a practical framework of standard terms for operating engineers, instrument engineers and mechanics.

• The election of Allen C. Menke as vice president of air conditioning and heating sales is announced by The Trane Co., La Crosse, Wis. In other promotions, R. H. Pearse, Jr., becomes sales manager, air conditioning; William C. Dackis, manager, heat exchanger sales; A. James Hackl, sales manager, packaged equipment; Harry F. Griese, Jr., manager, Climate Changer sales; and C. L. Ringquist, manager, applications engineering department.

• Thermo-Base Div., Gerwin Industries, Inc., announces the appointment of Dan Lynch as a vice-president. Mr. Lynch will assist in the expanded sales promotion program on the company's extended baseboard air distributors.

• Hugh H. Mallaney has been appointed sales engineer for the Chicago area, for Illinois Engineering Company. He will be responsible for the engineering and servicing of the company's line of steam and hot water heating equipment, traps, valves, and heat control systems.

• Richard F. O'Mara and Carl R. Flodin announce the formation of O'Mara and Flodin, Inc., engineers in the fields of dust and fume control—drying and air separation, with offices at 1111 Wilshire Blvd., Los Angeles, Cal.

OCEAN AIR ELEMENTARY SCHOOL, CITY SCHOOL BOARD, NORFOLK, VIRGINIA

John A. Simpson, A.I.A.
Architect, Norfolk, Va.

Another new school saves money with the Nesbitt Series Wind-o-line System

The $600,000 Ocean Air Elementary School of Norfolk, Virginia, will have "the thermal environment most conducive to learning" because Architect John A. Simpson specified *heating and ventilating by Nesbitt.*

By designing for a zoned, two-pipe, forced-hot-water installation, the architect reduced costs with the Nesbitt Series Wind-o-line System. Mains and piping were simplified; night controls and approximately 1,000 lineal feet of pipe covering were eliminated.

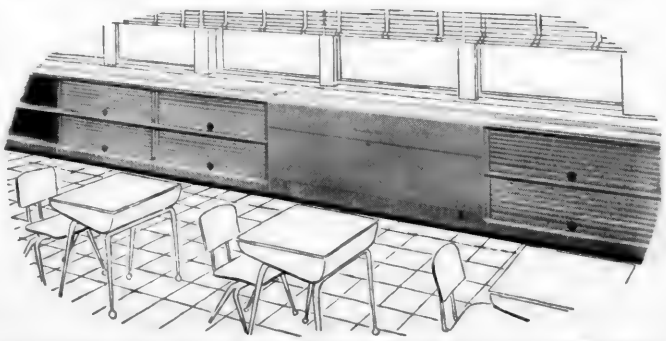
The key to the economy of the Nesbitt Series Wind-o-line System is the Syncretizer's hot water heating element which multipasses a much smaller quantity of higher temperature water than is circulated by conventional systems. This reduces the size of pipes and pumps and permits the Wind-o-line tubing to serve as supply and return piping for entire classroom wings, thus eliminating mains, costly pipe trenches, coverings, and runouts. Without other investment, the system's gravity heat maintains overnight temperatures.

Besides economy, the Nesbitt System offers greater comfort and protection. With the water temperature regulated by outdoor temperatures, the desired thermal environment is better maintained in every classroom and Wind-o-line protection along exposed surfaces is constantly related to actual needs.

Other systems requiring pipe trenches and runouts cost up to 20% more in construction, equipment and installation expenses. It will pay you to go Nesbitt.

Write today for Publication 104

Wind-o-line radiation may be had in wall-hung casings integrated with the Syncretizer, or recessed in standard Nesbitt storage cabinets. Architect Simpson chose this "Nesbitt Package" because it saved 30% over custom wood shelving.



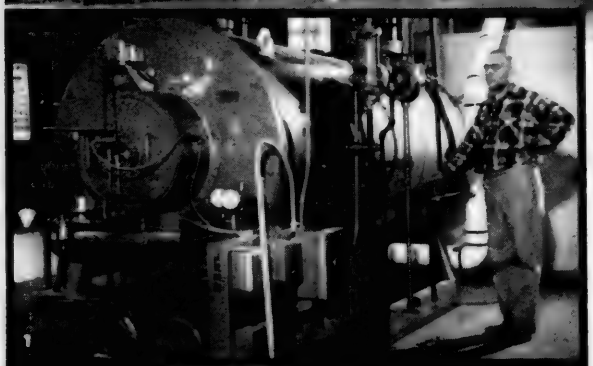
Nesbitt

SERIES WIND·O·LINE SYSTEM

MADE AND SOLD BY JOHN J. NESBITT, INC., PHILADELPHIA 36, PA. SOLD ALSO BY AMERICAN BLOWER CORPORATION

THEY SPELLED
E-C-O-N-O-M-Y
7 WAYS HERE

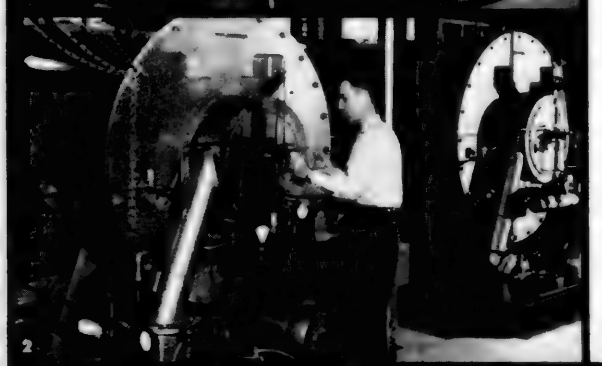
seven examples of how YORK-POWER equipment is meeting the rigid heating requirements of Architects, Engineers and School Authorities . . . *all over America*

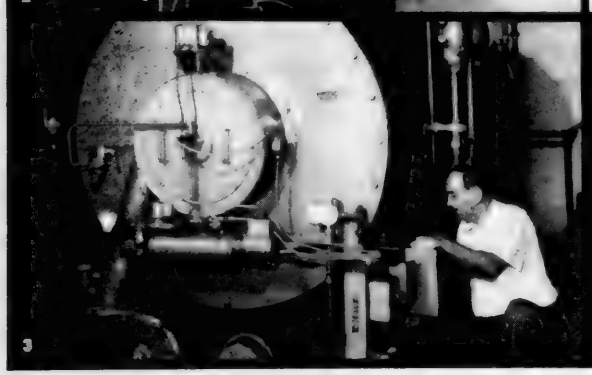


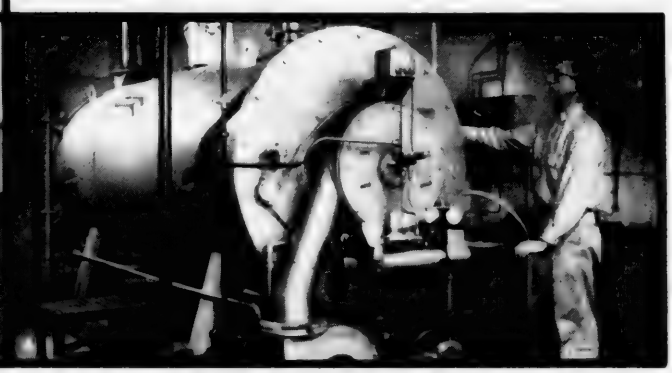
THESE seven modern schools, built in recent years in one section of Pennsylvania, are excellent examples of the high type of acceptance which YORK-POWER school-heating equipment has won and is winning in many other parts of the country.

Writes C. S. Buchart, Registered Architect, York, Pa., who designed these seven schools: "The York-Power Steam-Pak units installed in our projects have proven to be great space savers providing compact, neat, efficient heating installations of the advanced type required for economical planning."

States W. K. Hood of W. K. Hood & Associates, Inc., consulting engineers on these jobs: "We specify a Scotch marine type boiler for projects which require compact units with maximum efficiency. Many of these installations have York-Power equipment. They are providing economical, easy-to-operate service."







1. **ELEMENTARY SCHOOL, MT. ZION, PA.** This handsome, modern school, erected in 1954, is economically and efficiently heated by this single 60-hp York-Power Steam-Pak, (SPL53-60-5).

2. **ALEXANDER D. GOODE ELEMENTARY SCHOOL, YORK, PA.** Dependable and economical heat for this large elementary school is provided here by two 125-hp York-Power Steam-Paks (SPL53-125-5).

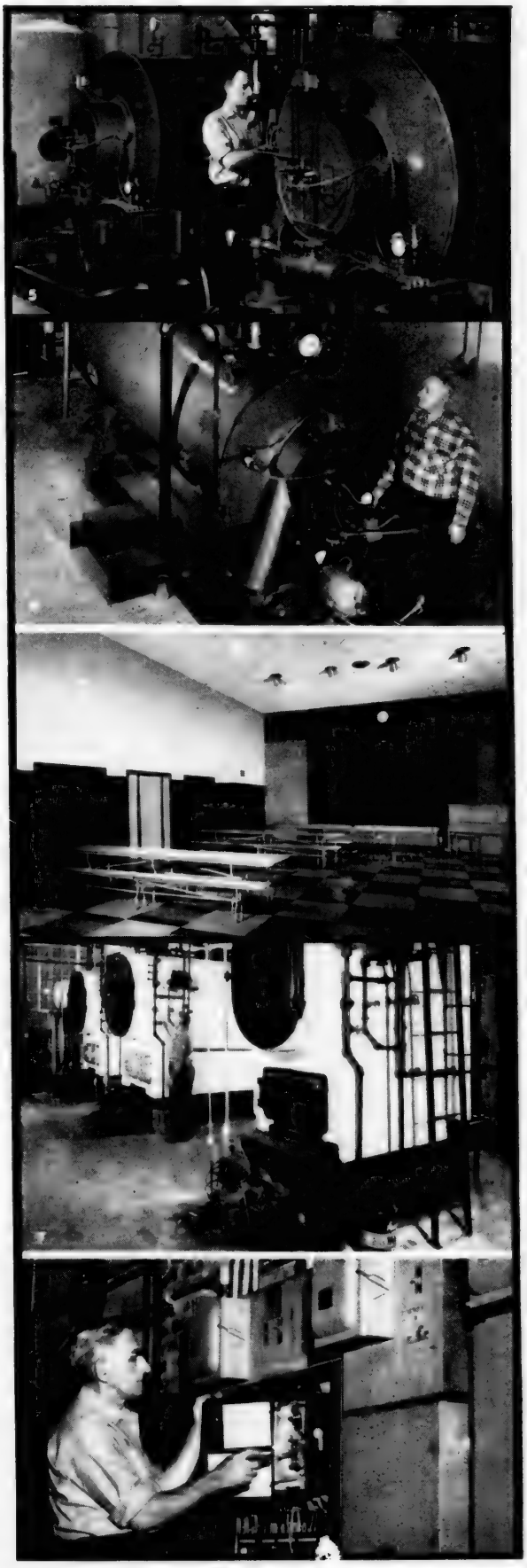
3. **ELEMENTARY SCHOOL, NEWBERRY TOWNSHIP, PA.** Illustration shows the heart of this school's heating system—a 100-hp York-Power Steam-Pak (SPL53-100-5).

4. **ELEMENTARY SCHOOL, FISHING CREEK, PA.** For this school, a single 60-hp York-Power Steam-Pak (SPL53-60-5) is sufficient to provide plenty of clean, economical heat and hot water.

5. **ELEMENTARY SCHOOL, CONEWAGO, PA.** Maximum heating efficiency is obtained here with two 75-hp York-Power Steam-Paks (SPL53-75-5).

6. **LIGHTNER ELEMENTARY SCHOOL, YORK, PA.** This 50-hp York-Power Steam-Pak (SPL53-50-3) provides abundant, economical heat for the above-mentioned school. Illustration below shows combination auditorium and cafeteria with tables that fold into the wall. York-Power keeps pace with such modern school equipment ideas.

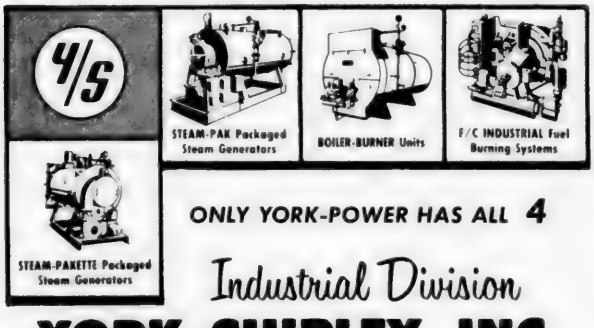
7. **YORK TOWNSHIP ELEMENTARY SCHOOL.** Big savings and greater heating efficiency have been reported by this school since they converted two 50-hp coal-fired boilers by the installation of York-Power Horizontal Rotary Oil Burners. A third 25-hp boiler was installed in the space formerly occupied by the coal bin. Each unit is controlled by Factory-Coordinated panels (below). All controls were wired at the factory, eliminating costly on-the-job installation.



YORK-POWER UNITS in use everywhere

Remember, wherever you go you'll find York-Power heating installations similar to these . . . installations which are meeting the high performance and low-cost demands of state, county, and municipal school authorities—as well as industry and commerce.

YORK-POWER Units are designed and built to fire light oil, heavy fuel oil; mixed, manufactured or natural gases, or a combination of oil and gas. Your nearest York-Shipley Representative will be happy to help you with the solution of any school heating problem. Call him or write directly to YORK-SHIPLEY TODAY.



ONLY YORK-POWER HAS ALL 4

Industrial Division

YORK-SHIPLEY, INC.

YORK, PENNSYLVANIA

Typical plant ceiling showing foil-faced Pittsburgh Fiber Glass insulation in position.

"Pittsburgh Superfine is easiest to apply... most efficient insulation for steel buildings"

SAYS MR. CHARLES W. JACKSON, *President of Quonco, Inc., fabricated steel building sales and erection firm of Indianapolis, Ind.*

Experience has taught Quonco, Inc., that it takes more than conventional material to properly insulate a fabricated steel building. First of all, the material must be self-supporting and preferably blanket-type. It must be lightweight and very easy to handle. Further, it must be extremely efficient in insulating against heat loss and absorbing noise.

Quonco found all of these insulation advantages in one product—Pittsburgh Superfine Fiber Glass. Mr. Jackson, President of the Indianapolis firm, sums up the advantages this way: "Since Pittsburgh Superfine in our buildings reduces heat loss to only ⅓ that of conventional masonry buildings, our customers can plan for a lower initial investment in heating equipment and cut their estimated fuel costs considerably." As an example, Mr. Jackson cites the case of the world's largest fabricated steel building—7½ acres—in which 300,000 sq. ft. of Pittsburgh Superfine was used. Only one of the plant's three boilers, and 7 of the plant's 12 air supply units is needed to maintain a comfortable 75° for over 3000 employees. Even during hot summer months, temperatures are 10° to 15° cooler inside without air conditioning.

If plant and office modernization or construction is part of your current plans, be sure to know about the unusual features and savings that Pittsburgh Superfine insulation can provide you. For your copy of Bulletins F-100 and F-140, write Fiber Glass Division, Pittsburgh Plate Glass Company, One Gateway Center, Pittsburgh 22, Pa. For immediate service on your specific problem, you can call the nearest Fiber Glass Division sales office listed below.

PITTSBURGH SUPERFINE FIBER GLASS IS A PRODUCT OF THE FIBER GLASS DIVISION OF PITTSBURGH PLATE GLASS COMPANY

Sales Offices are located in the following cities: Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Los Angeles, New York, Philadelphia, and St. Louis

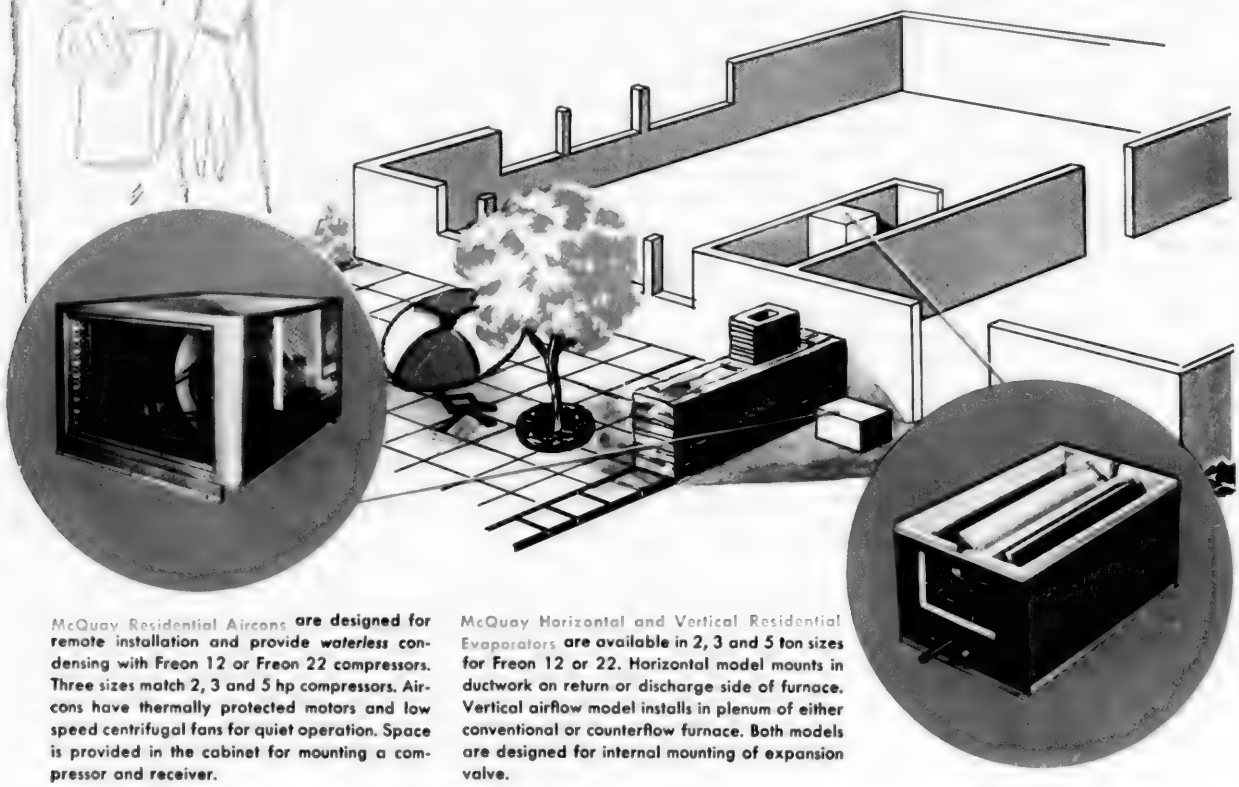
FIBER PG GLASS

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

McQuay residential air conditioning components

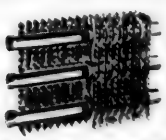
ADD LOW COST COOLING TO FORCED AIR FURNACES



McQuay Residential Aircons are designed for remote installation and provide *waterless* condensing with Freon 12 or Freon 22 compressors. Three sizes match 2, 3 and 5 hp compressors. Aircons have thermally protected motors and low speed centrifugal fans for quiet operation. Space is provided in the cabinet for mounting a compressor and receiver.

McQuay Horizontal and Vertical Residential Evaporators are available in 2, 3 and 5 ton sizes for Freon 12 or 22. Horizontal model mounts in ductwork on return or discharge side of furnace. Vertical airflow model installs in plenum of either conventional or counterflow furnace. Both models are designed for internal mounting of expansion valve.

A new McQuay Residential Evaporator and Residential Aircon are now available to meet the demand for low cost central cooling in existing and new home construction. Furnace filters, blower and ducts combine with a McQuay Evaporator to provide clean, cool, de-humidified air to all rooms. The McQuay Aircon, in which you may mount your compressor and receiver, handles the refrigerant condensing with a minimum of piping and *without the use of water.*



McQuay Ripple-Fin Coils—Both evaporator and condenser in this residential system are built around a McQuay Ripple-Fin Coil. Rippled aluminum fins assure thorough air cooling by prolonging the air contact with the cooling surface. The McQuay design also staggers the copper tubes to increase this effect.

McQuay Inc.

Representatives in major cities

1600 Broadway N. E., Minneapolis 13, Minn.

Beth-Co-Weld Pipe is used for heating lines in R. H. Macy and Co. suburban store, White Plains, N. Y.
Contractor: Wolff & Munier, New York. *Jobber:* Chas. F. Guyon, Inc., New York.

These Recently Completed Buildings Use Beth-Co-Weld Steel Pipe

These two new structures, one a store at White Plains, N. Y., the other a factory building at North Wales, Pa., have one thing in common—a network of Beth-Co-Weld steel pipe.

For virtually any type of construction you can name, Beth-Co-Weld is a wise choice for general-purpose piping. This is because Beth-Co-Weld is a quality product, manufactured from sound steel by the continuous-weld process. It is economical pipe, in the shop and out on the job, because it's so easy to work.

Beth-Co-Weld is made in sizes from ½ in. to 3 in., standard-weight and extra-strong weight, and in 21-ft lengths, plus or minus 1 in. It is also produced in 3½-in. and 4-in. sizes, in standard-weight only.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

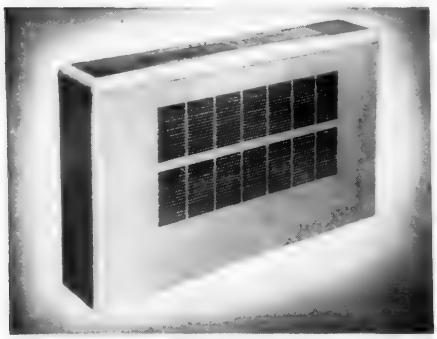
About 70 tons of Beth-Co-Weld are used in this new plant of Leeds & Northrup Co., North Wales, Pa. *General Contractor:* H. E. Baton, Philadelphia. *Mechanical Contractor:* Riggs Distler & Co., Inc., Baltimore. *Jobber:* B. H. Deacon Company, Inc., Philadelphia.

BETHLEHEM STEEL

BETHLEHEM STEEL

for your multi-room jobs...

There's a UniTrane Air Conditioner for any system, any building, any size



All UniTrane Air Conditioners, including the Induction UniTrane model shown above, are designed to filter *all the air* . . . not just primary air. Individually controlled for personal climate preferences or changing needs.

Now! For complete design flexibility for multi-room air conditioning systems, it's UniTrane Air Conditioners for 1956! This famous TRANE line is now more versatile than ever, with models of *both* basic types—*fan-coil and induction*—to choose from. Units are *trimmer*, with slim, space-saving design. And they're easy to install, with simple piping and wiring connections.

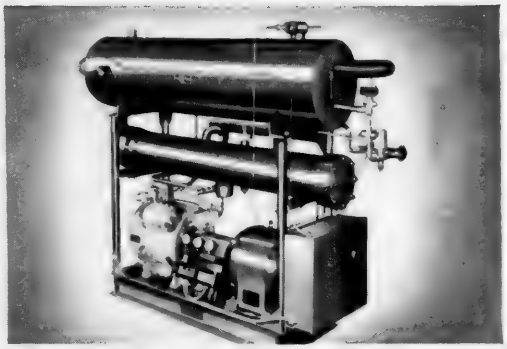
There's a UniTrane model to meet the most exacting requirements for multi-room, multi-story applications —for new or existing buildings, of any size or type. You may choose the attractive floor model (shown above); ceiling types; concealed models for "built-in" applications.

Ask your nearby TRANE Sales Office for complete data on the UniTrane models for 1956. See how they can help you with almost any air conditioning job for any system, any building, any size!

For heating, cooling, ventilating...
For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS



TRANE Cold Generators, "packaged" water chillers for your smaller refrigeration requirements, have multi-step capacity control that reduces starting and stopping, saves power. Cadmium-coated compressor valves for nine-times longer life! Now in 8 models, including 125 and 150 h.p. sizes.

For heating, cooling, ventilating...
For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS

THE TRANE COMPANY, LA CROSSE, WIS. • EASTERN MFG. DIV., SCRANTON, PA.
TRANE COMPANY OF CANADA, LTD., TORONTO • 90 U.S. AND 19 CANADIAN OFFICES

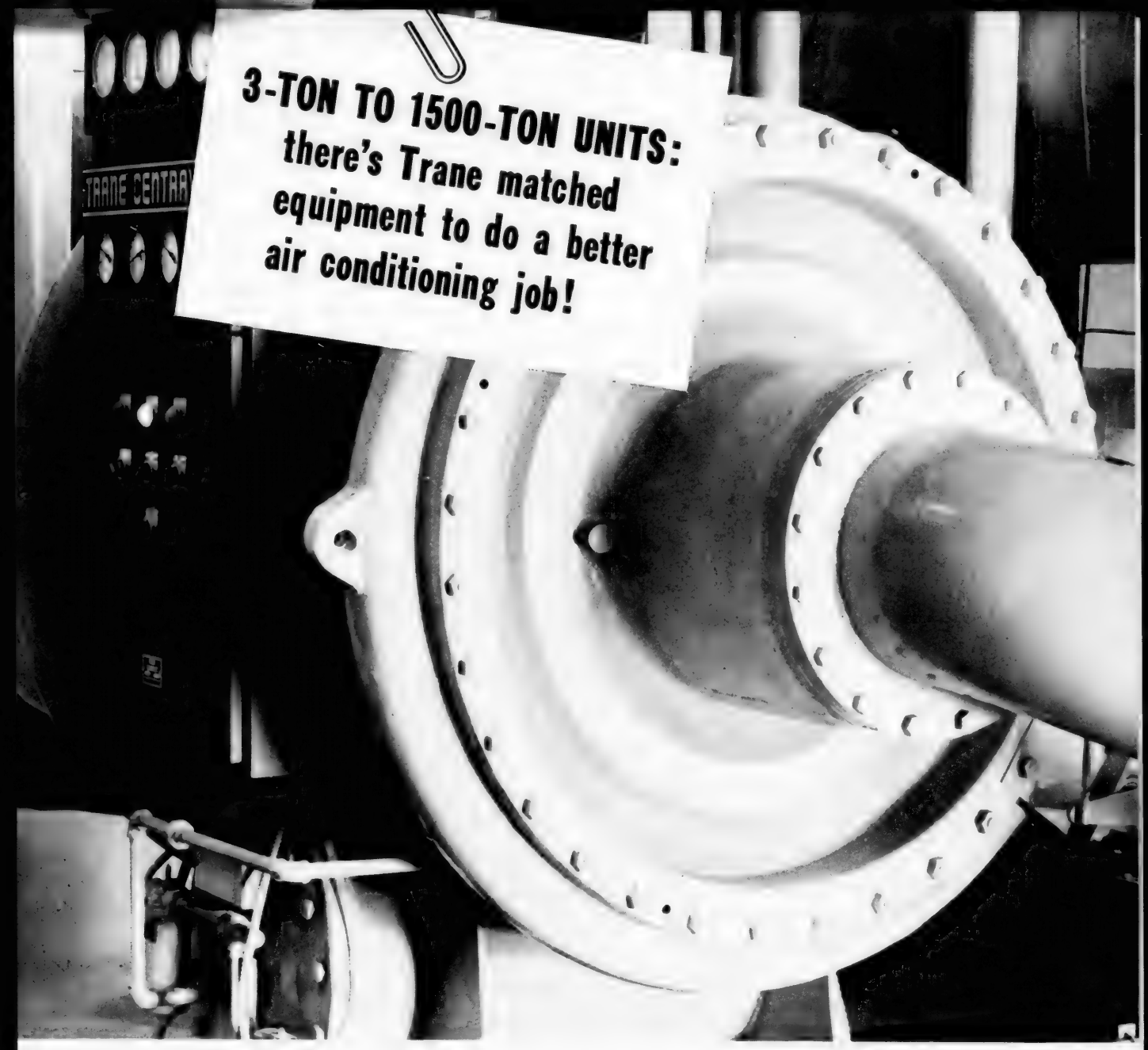
For closer control of air conditioning costs...

Make it a "packaged" size job...CenTraVac

For over 17 years the versatile TRANE Compressor, the *first hermetic centrifugal in the industry*, has simplified problems in design, installation and operation of air conditioning equipment. Completely automatic, it starts, stops, runs by itself—automatically limits its use of power from 100% down to 10%, in *almost direct proportion to the cooling load!*

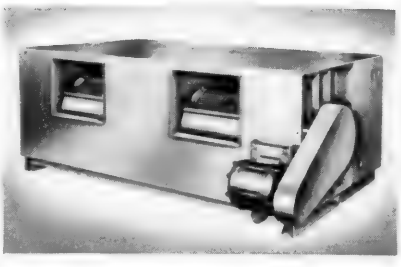
And now, for 1956, larger size units—up to 1500 tons—give you "packaged" equipment for even the largest air conditioning job. Compact, quiet, vibration-free, the CenTraVac is easy to install . . . *no special bases . . . no field alignment.* Install it anywhere from basement to penthouse—even outdoors!

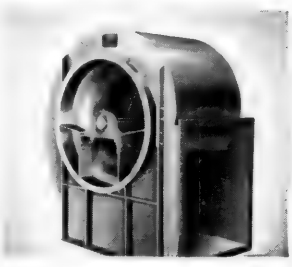
Ask your nearby TRANE Sales Office for complete data on TRANE "packaged" water chillers—the famous TRANE CenTraVacs and Cold Generators—and other TRANE *matched* air conditioning equipment. Or write TRANE, La Crosse, Wis.



Trane water chiller for any units now up to 1500 tons

TRANE Climate Changers are versatile, flexible air-handling units that help solve a variety of air conditioning design problems. Single zone models, or multi-zone, for handling up to 6 zones at the same time. A wide range of sizes and capacities to 29,000 cfm. May be used for heating or cooling.





TRANE Class III Fans, now in a wider range of *standard* sizes, bring you new freedom of design. Designed especially for high-pressure air conditioning systems. 15 *standard* sizes from 18 to 73 inches. Rated capacities to 310,000 cfm. Split housing construction for fast, easy installation.

Trimmer, slimmer, quieter
Trane Self-Contained Air Conditioners meet every engineering requirement

"Commercial" sizes of 10, 15, 20 tons have outstanding dependability that insures efficient performance. Multi-step capacity control reduces starting and stopping, saves power.

Trim, slim, quiet, it's the TRANE Self-Contained Air Conditioner for 1956! Completely redesigned, inside and out, these 3, 5 and 7½ h.p. units pack efficiency and performance into sleek, modern cabinets. And they run so *quietly*, the occupants can hardly hear them—thanks to new TRANE "iso-sound" design that has both fan section and compressor section *floating independently* on sound and vibration isolators.

With a 5-year-guaranteed hermetic compressor as the heart, these complete-in-one-package air conditioners are engineered and built by TRANE. And for your further protection, TRANE has a nation-wide service organization.

For heating, cooling, ventilating...
For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS

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EASTERN MFG. DIV., SCRANTON, PA. • TRANE COMPANY OF CANADA LTD., TORONTO • SALES AND CANADIAN OFFICES

After 25 years in a hospital—

Here are the two H. B. Smith 60 Series Boilers as they looked in the boiler room of the hospital during their first 25 years.

They look well, don't they!

Here are the two H. B. Smith 60 Series Boilers as they look today in the boiler room at Framingham Motor Inn.

Motorists who get around agree that the Framingham Motor Inn at Framingham, Massachusetts, is one of the finest and most modern motor courts in the country.

It isn't surprising that the heat and hot water for this 102-unit paragon of repose are supplied by two H. B. Smith boilers. Nor is it surprising *to those who know boilers* that the two boilers selected for the installation *already had served for a quarter-century in a Rhode Island hospital!*

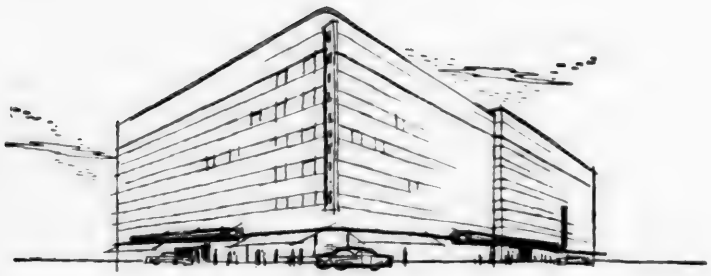
After 25 years of day and night service, conventional boilers would be ready for retirement . . . but H. B. Smith boilers are still going strong. This is because they have vertical cast iron water tubes which are an integral part of the boiler, and are highly resistant to fuel acids and feedwater impurities.

H. B. Smith boilers respond quickly, and maintain high efficiency with minimum attention. Maintenance costs are negligible and new sections can be added to provide greater heating capacity as a building is expanded.

Framingham Motor Inn can look forward to another quarter century of service from these boilers. After all — they've had *experience!*

H.B. Smith **CAST IRON BOILERS**

H. B. SMITH CO., INC., WESTFIELD, MASSACHUSETTS • *Established 1853*



Comfort story of a modern department store

How Honeywell Electronics makes

Shillito's Department Store, Cincinnati, O., a Federated Department Store.
Engineer: Leo S. Weil & Walter B. Moses, New Orleans, La., and St. Louis, Mo. Architect: Potter, Tyler, Martin & Roth, Cincinnati.

Typical shopping areas in Shillito's illustrate need for accurate control of large open spaces—maintained ideally by Honeywell Electronic Temperature Control. Other major advantages of the installation are:

. . . ***central control***—one operator at the Honeywell Supervisory DataCenter can read and adjust temperature at 36 locations throughout the store.

. . . ***savings on cooling***—outside air is used to help cut costs of refrigeration.

. . . ***savings on maintenance***—with central electronic control, fewer men are needed to maintain all mechanical equipment.

. . . ***quick response*** of electronic control system keeps indoor climate ideal regardless of changes in customer occupany.

central air conditioning pay off

Honeywell Supervisory DataCenter provides central control of modernized air conditioning system in seven-story building

A MODEL of centrally air conditioned comfort—that's Shillito's Department Store, southern Ohio's largest.

It's a model of air conditioning convenience and economy, too—thanks to Honeywell Electronic Temperature Control, chosen to govern the Cincinnati store's recently installed central heating and cooling system.

Air conditioning units scattered throughout the store had caused discomfort and maintenance headaches. Shillito's management wanted a new central system—and *central control* of the system. Honeywell Electronics provides it.

One man now can control the entire system from the Honeywell Supervisory DataCenter. At this single point he can adjust 38 thermostats and check temperatures at 76 different locations divided among the store's seven floors.

The result is better shopping climate for customers; better supervision of the air conditioning system that saves money for management—on fuel, power and maintenance.

Honeywell Electronic Temperature Control offers many unique advantages in air conditioning management. It can serve your clients well in any building, new or existing, by providing new efficiency and economy in heating, ventilating, air conditioning and industrial control.

Call your Honeywell office for the new booklet that tells more fully how to apply electronics to your clients' problems—and for information on the economical Honeywell Periodic Maintenance Plan. Or write Honeywell, Dept. HV-6-102, Minneapolis 8, Minn.

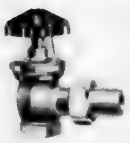
MINNEAPOLIS **Honeywell**

112 offices across the nation

H HONEYWELL **Electronic Controls**

MARSH PACKLESS RADIATOR VALVES

WHEEL HANDLE



GRADUATED

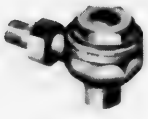
LOCK AND SHIELD

ANGLE PATTERN

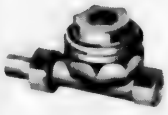
GLOBE PATTERN

CORNER PATTERN (Sectional Below)

MARSH THERMOSTATIC RADIATOR TRAPS



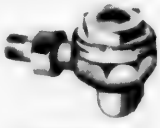
ANGLE PATTERN



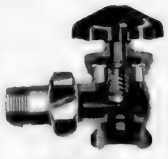
STRAIGHTWAY PATTERN

VERTICAL PATTERN

LEFT HAND CORNER PATTERN

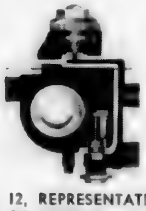


RIGHT HAND CORNER PATTERN



CUT OPEN VALVE

F&T TRAPS



No. 12, REPRESENTATIVE OF WIDE LINE

VENTS

No. 5 VENT, ONE OF MANY

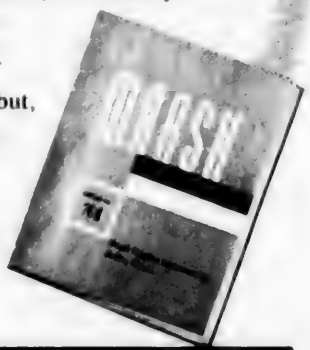
BUCKET TRAPS

No. 500 INVERTED BUCKET TRAP

All the best of their kind!

You probably have made certain Marsh products your standbys without realizing there are a lot more of them just as superlative as the ones you like so well.

Make the acquaintance of some of them here, but, better still—***Ask for this Marsh Catalog!***



MARSH HEATING EQUIPMENT CO.
Sales affiliate of Jas. P. Marsh Corporation
DEPT. U. SKOKIE, ILL.
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd St., Edmonton, Alberta

MARSH
Heating Specialties since 1865

MARSH BOILER GAUGES

THER-ALTI-METER (Square and Round)

INTERNAL SYPHON (Square and Round)

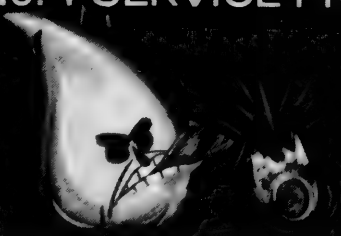
OUNCE-GRADUATED RETARD (Also Compound)

STANDARD (Also Compound)

General Chemical Presents

MOISTURE

Dramatized Story of the Cause and Cure
of REFRIGERATION'S No. 1 SERVICE PROBLEM



Educational, Entertaining
SOUND-SLIDE FILM
IN FULL NATURAL COLOR

Prepared under the technical direction of DR. WALTER O. WALKER, "Genetron" Consultant and Dean, Division of Research and Industry, University of Miami.

A Full Report Highlighting

- **Sources of moisture in refrigeration systems.**
- **Problems and damage caused by moisture.**
- **Recommended methods for removing moisture.**

Here's information of real practical value to the air conditioning and refrigeration service engineer . . . a sound-slide film prepared by General Chemical to help you handle the problem of moisture in refrigeration systems.

"Moisture" is a swift-paced, 35-minute sound-slide film in full natural color. It is instructive, informative . . . gives authoritative, up-to-the-minute information on every phase of the costly moisture problem.

Full of "how-to-do-it" topics! Covered are: how moisture gets into the refrigeration system and how to keep it out; the problem of "freeze-ups" and its solution; the causes of corrosion; how moisture reacts to form destructive acids and sludges; how insulation breakdown and motor burnouts are related to moisture; sound practices for care in the field; how to purge moisture from the refrigeration system; how to dry out a system with or without an oven; facts about desiccants, etc.

Refrigeration Service Engineers Society Members are invited to show this film at their chapter meetings.

Refrigeration and air conditioning wholesalers, equipment manufacturers, and contractors are invited to make full use of it in briefing their organizations on moisture control, and to show it at meetings for customers. Also available to technical schools and colleges offering refrigeration courses.

Send coupon for loan of full-color print and record. Free prints also available on long term or permanent basis; write for particulars.

"Genetron" Department
GENERAL CHEMICAL DIVISION
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Without cost or obligation, I would like to have a print and record of "Moisture" on loan for showing (state preferred dates) _____

☐ If you do not have a sound-slide projector, check here and a General Chemical representative will arrange a showing for you.

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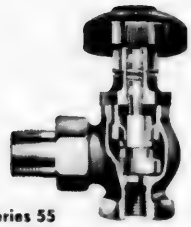
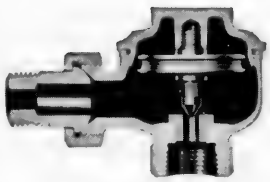
To the architect and engineer an Illinois Control System of Steam Heating means lasting client satisfaction; to the heating contractor, simplicity and ease of installation; to the owner, a sound investment in comfort, convenience and fuel economy.

Illinois Control Heating Systems are found in schools, hospitals, churches, apartments, commercial and public buildings of every type from coast to coast. They are offered in five types, and cover the complete range of vacuum and vapor heating requirements.

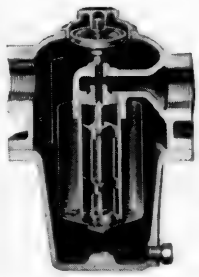
Consult the representative nearest you in our nation wide service.



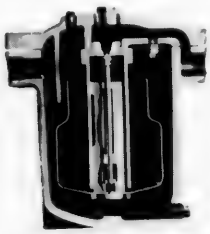
Series 55
Radiator Valve



Series G
Radiator Trap

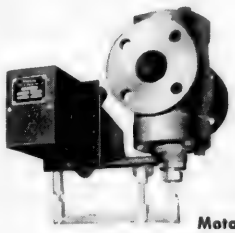


Float and
Thermostatic
Trap

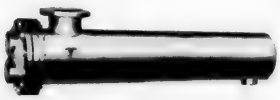


Series 35 Steam Trap

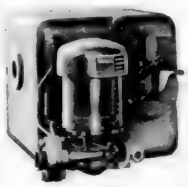
Pneumatic
Zone Control
Valve



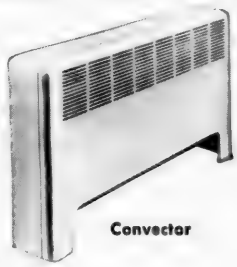
Motorized
Zone Control Valve



ASU Heat Exchanger



Condensation Pump



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Illinois Heating System Specialties

Installing Illinois Specialties, either in new projects or to replace present worn equipment will insure maximum service and economy. Illinois systems are scientifically balanced. All specialties are of our own manufacture, designed for coordinated operation. Manufacturing a complete range of devices enables us to select those that will give the desired results under the most exacting and widely varying requirements.

Illinois Power Specialties

In addition to the equipment illustrated there is also a complete line of power specialties—for medium and high pressures.

No matter what your problem in the handling or control of steam and condensate may be, we will be glad for the opportunity to discuss it with you.

Write for bulletins

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DIVISION OF AMERICAN AIR FILTER COMPANY, INC.

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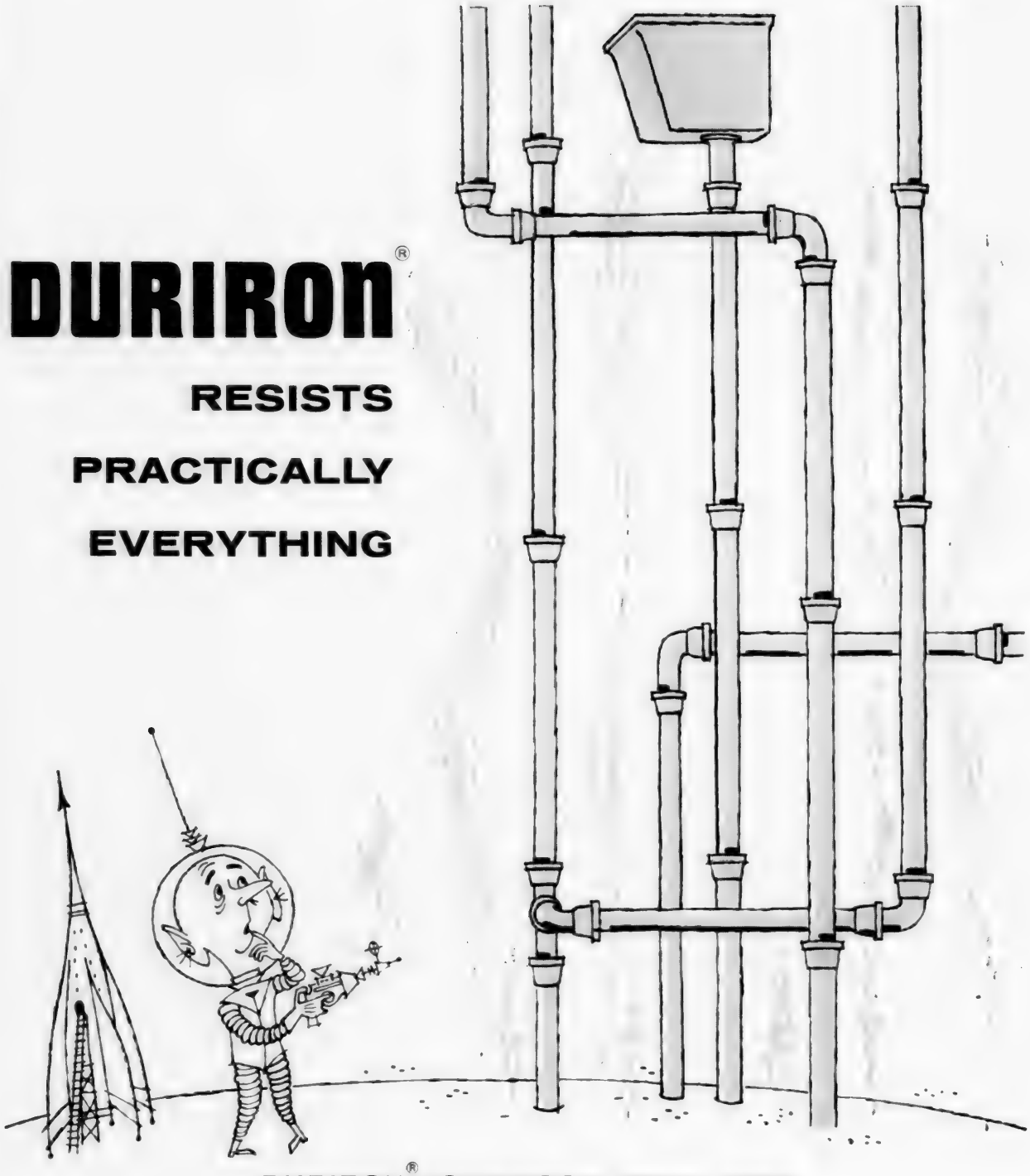
RESISTS PRACTICALLY EVERYTHING



DURIRON® ACIDPROOF DRAIN PIPE

Duriron is *the* high silicon iron specified by architects and engineers for more than thirty years for permanent corrosive waste disposal lines. Duriron is corrosion resistant to practically all commercial acids and other corrosive solutions. Duriron is ideal for schools, hospitals, laboratories, commercial kitchens . . . wherever *permanent* waste disposal lines are required.

DURIRON
LOOK FOR THE NAME ON EVERY PIECE

THE DURIRON COMPANY, INC.
DAYTON, OHIO

...yscraper in "the world's most air conditioned city."
Houston's new landmark is owned jointly by The Texas National Bank
and The Continental Oil Company. Floor space is approximately 560,000 sq. ft.

TEXAS National BANK
OF HOUSTON

Huge revolving sign with 15 ft. diameter WEATHER EYE, 85 feet above the 21 story building flashes weather forecasts by color.

Architect
Kenneth Franzheim
Engineers
Bernard Johnson & Associates
Contractors
Barber Plumbing, Inc.
and Straus Frank Co.

POWERS *System of individual room* Air conditioning control *used in this colorful building*

The ultimate in comfort has been provided for the occupants of this beautiful building. With individual room control they can select and enjoy the temperature they want.

Maximum year-round comfort, obtained with 640 Powers pneumatic summer-winter thermostats controlling 1500 air conditioning units, helps increase employee efficiency.

When you want modern individual space temperature control specify a Powers pneumatic system. The advantages of its simplicity and dependable performance have been *proven* in many of the nation's prominent buildings.

THE POWERS REGULATOR COMPANY

Skokie, Illinois | Offices in Chief Cities in U.S.A., Canada and Mexico

65 Years of Automatic Temerature and Humidity Control

(c54)

here's what heating and ventilating contractors say about INLAND TI-CO®

Galvanized Steel

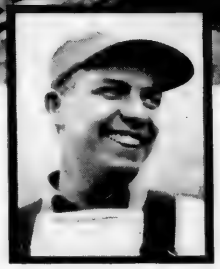
. . . says James N. Johnson, Shop Supt. of The Austin Sheet Metal Co., Chicago, Ill. "Ti-Co keeps our labor costs down! When you're the sheet metal contractor for large housing projects involving hundreds of homes, such as the Brynhaven development in Elmhurst, it's necessary to keep a large inventory of fittings in stock. Mass production of sheet metal fittings can be costly if you're having trouble with cracking and flaking of the "iron". That's why we like Inland's Ti-Co. We never have to waste time and money doing an intricate fitting over again because Ti-Co's coating never comes off."

. . . says P. W. Olmen, President of Jamar-Olmen Co. and W. A. Kuechenberg, President of R. B. Hayward Co., co-contractors of the sheet metal work on Chicago's new Prudential Building. "We used Ti-Co exclusively for all the duct work for air handling in the Prudential Building. Over 1,000 tons went into the job in all . . . the largest single air handling sheet metal job ever undertaken in Chicago. With Ti-Co we knew we could depend on getting uniformity of coating and base metal."

. . . says Maurice L. De Wulf, heating contractor of Roselle, Illinois. "Ti-Co Galvanized sheets cut my fabrication costs 20 to 25%! Figure for yourself what it costs to form a 10-foot heating duct with a Pittsburgh lock seam. Then if the zinc coating flakes or peels along the seam—*just double the cost!* The job has to be done over, and though you may be able to salvage some of the material, you can't salvage those wasted man-hours."

. . . says Mr. Earl Rocky, Supt. of O. A. Wendt Co., Chicago, Ill. "I wouldn't use anything but Ti-Co in my shop. We have been using close to 500 tons of Inland Ti-Co per year for the past several years and I have yet to have a sheet flake on me. Even on the lockseamer, and we make our seams especially tight, Ti-Co performs beautifully. Ask any of the boys in my shop and they'll tell you the same thing."

. . . says H. G. Prizant, Owner and Manager of H. G. Prizant Co., Chicago, Ill. "We depend on Ti-Co for our profit. Take this intricate installation in the new University of Illinois Dentistry Building, for example. Although the galvanized steel cost less than $10, there was probably about $250 worth of labor in this piece. If the sheets cracked along the lock seams, or even if their zinc coating had flaked off severely, it would have meant re-doing the entire job. With Ti-Co we don't have to worry about re-doing jobs because of steel failure."



. . . says Fred Rickey, Supt. of F. R. Inskip & Co., Champaign, Ill. "Ti-Co Galvanized sheets save us 50¢ a sheet. We used to waste a lot of time and material with conventional galvanized before they were ready for pattern layout. We lost about ten minutes shop-time on the shear and about a pound of metal. Then we had to refigure the sheet size to make a layout. We don't have this waste using Inland Ti-Co sheets. They're always uniform. We make layouts and shear Ti-Co as delivered. And we save at least $2,500 a year."

Yes, more and more sheet metal contractors throughout the middle west are learning the tremendous difference between Ti-Co and just any conventional galvanized sheet. Inland Ti-Co is made by a special continuous galvanizing process which eliminates the brittle iron-zinc layer that causes conventional galvanized coatings to flake.

Ask your dealer for Inland Ti-Co and look for this stencil on all your galvanized sheets.

INLAND STEEL COMPANY

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Sales Offices: Chicago • Milwaukee • St. Paul • Davenport
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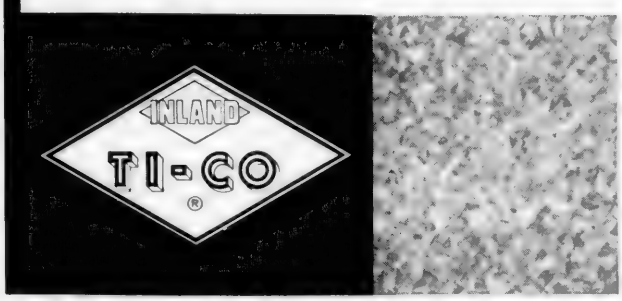
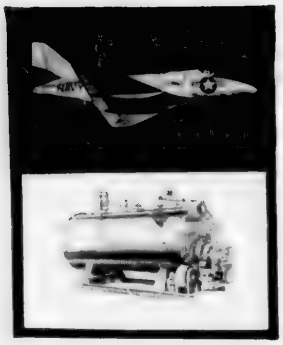
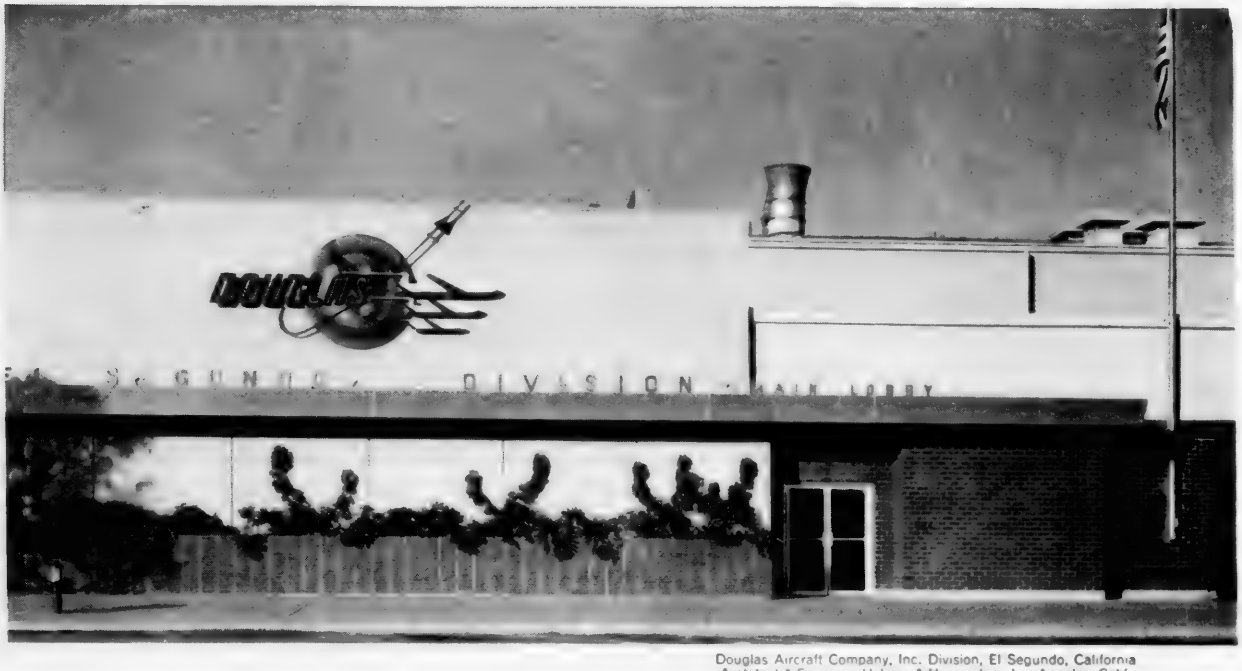




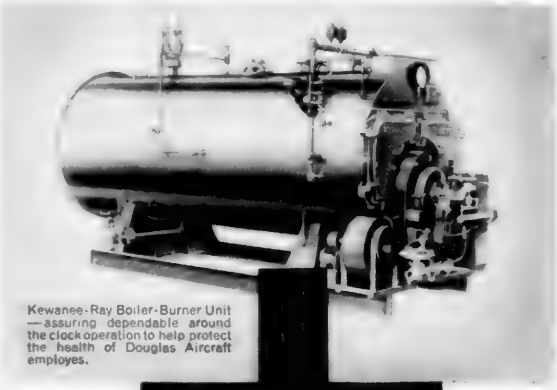
Sisters under the skin . . . when it comes to "cruising speed"



Douglas Aircraft Company, Inc. Division, El Segundo, California
Architect & Engineer: Holmes & Narver, Inc., Los Angeles, Calif.
Heating Contractor: E. Willardson, Inc., Los Angeles, Calif.

■ No one knows the importance of "cruising speed" operation in aircraft better than the Douglas Aircraft people. They know an airplane, to be efficient, to operate economically, to have longer life, must fly at "cruising speed." They know, too, there must be extra reserve power for take-off—for emergencies. So, when it came to boiler selection for the new A4D Skyhawk production facilities at their El Segundo, California Division, it was only natural they turned to Kewanee Reserve Plus Rated Boilers with 50% extra built-in power assuring "cruising speed" operation. For "cruising speed" means less strain—less wear. It means higher efficiency . . . it means lower maintenance and repair costs. Kewanee Boilers are rated on nominal capacity with reserve to take care of normal needs—meet emergencies of the present—fluctuating loads and future expansion. A boiler rated on maximum capacity, operating at constant top speed, requires more maintenance, constant attendance, and finer burner adjustment to maintain efficiency. So, choose Kewanee—for lower fuel and maintenance costs more efficient "cruising speed" operation.

KEWANEE BOILER DIVISION of AMERICAN-Standard
101 Franklin Street, Kewanee, Illinois



Kewanee-Ray Boiler-Burner Unit —assuring dependable around the clock operation to help protect the health of Douglas Aircraft employes.

KEWANEE
reserve plus rated

KEWANEE BOILERS

You can depend on Kewanee engineering

What's Your COPPER TUBE Problem

YOUR READING TUBE DISTRIBUTOR HAS THE ANSWER – *Tailor-Made for You!*

QUALITY PRODUCT

At Reading, we make tubing and *only* tubing —in one of America's most modern, completely integrated mills. By specializing. we can deliver a better product to you . . . a product that you can depend upon to build good will, as well as your business.

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Wherever your warehouse, you're within easy reach of a Reading Tube depot. You can always be sure of getting the right amount of tubing, at the right time, to meet even the most urgent orders.

EASY TO HANDLE PACKAGE

All Reading Copper Tubing comes packed in handy "Readi-Pakt" cartons . . . clearly labeled for instant identification . . . easy to handle and store . . . designed to afford utmost protection.

SCIENTIFIC QUALITY CONTROL

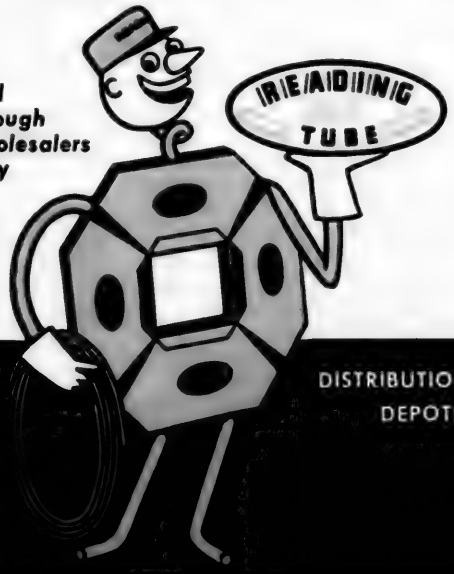
Reading's unique 4-way inspection checks and certifies accurate adherence to the most exacting standards. Constant metallurgical, hydrostatic, physical and visual tests make any product bearing the Reading label a product that's second to none in the industry.

RESEARCH

In Reading's research laboratory, expert technicians are constantly on the alert for new ideas . . . continually searching for new methods to improve our products . . . striving to maintain that degree of quality and performance for which Reading Copper Tube is famous throughout the industry.

ENGINEERING

Reading's Field Engineering Department — staffed by competent tubing engineers who are thoroughly trained to handle all types of Copper Tubing problems — is at the disposal of our Distributors at all times.



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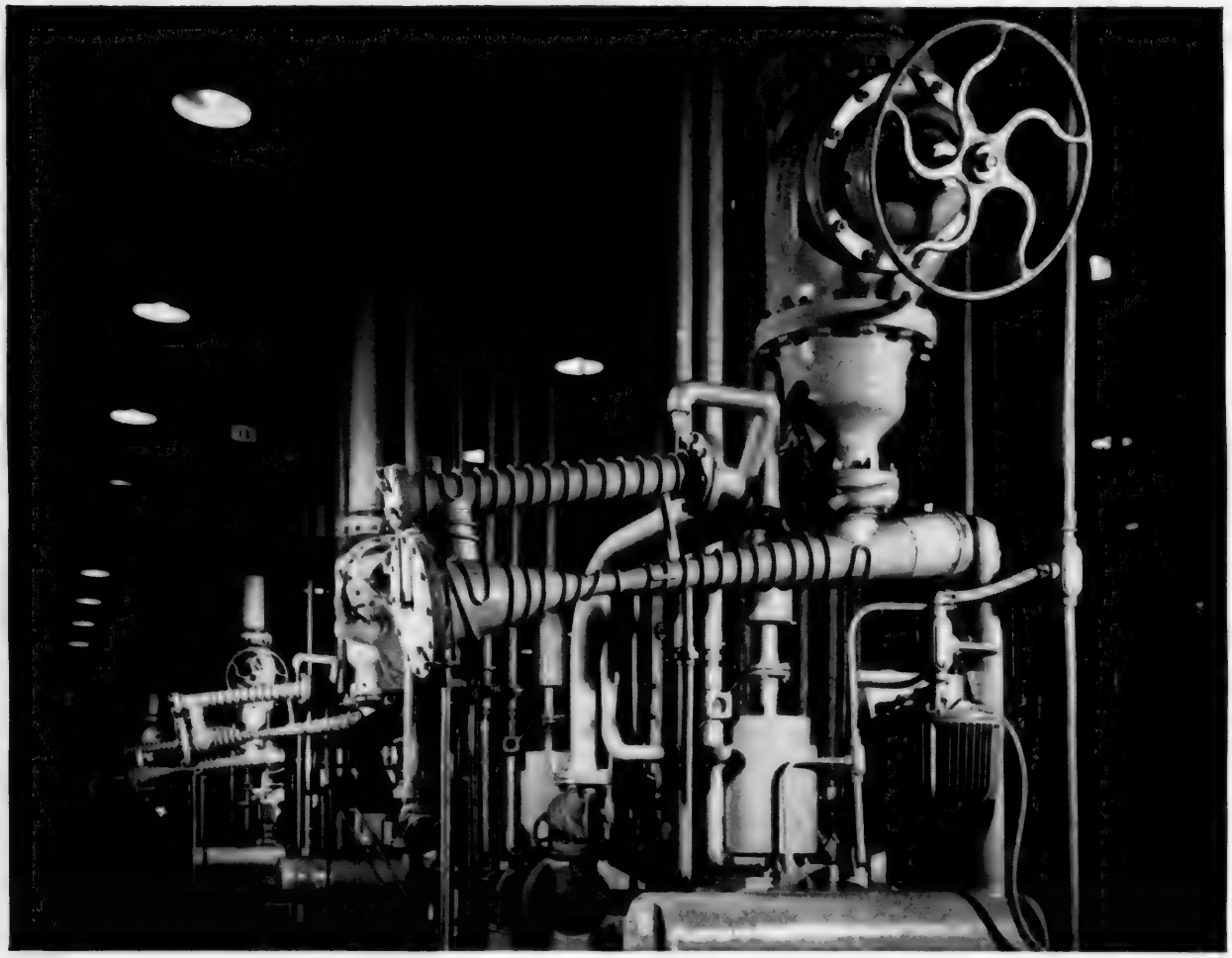
DENVER, COLO. 2845 Walnut St.
CLEVELAND, OHIO 4615 Perkins Ave.
ATLANTA, GA. 680 Murphy Ave. S.W., Unit 5, Bldg. B



These Crane valves holding 25 microns absolute pressure after 2 years on vacuum service

The Case History—Valves frequently are the most critical points in a vacuum system. But that's not the case with this large Southern light metals refiner.

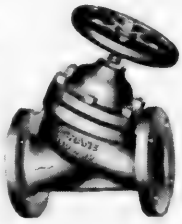
This plant reports no trouble or expense over a 2-year period in maintaining a vacuum of less than 25 microns absolute for its distillation process.

The tight-holding valves installed about 2 years ago on the lines from vacuum pumps shown above are Crane No. 1611 diaphragm pattern. These 12-in. packless iron body valves are used about once daily.

They've allowed no in-leakage at the seat, bonnet-joint, or through the diaphragm. No maintenance whatever has been given the valves since installed. They operate easily and look good for such service indefinitely.

This high efficiency performance is mainly due to Crane separate disc and diaphragm design. The diaphragm used as a bonnet seal only is not subject to destructive crushing. Conventional type disc and body seat provide a metal-to-Neoprene seating that's ideal for vacuum and hard-to-hold fluids.

Moderately priced, Crane diaphragm valves deserve your consideration for many ordinary services, as well as sludges, slurries and corrosive fluids. They are made in a wide variety of body and trim materials, in ½ to 12 in. sizes.



Ask your local Crane Representative about them, or write to address below for literature.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

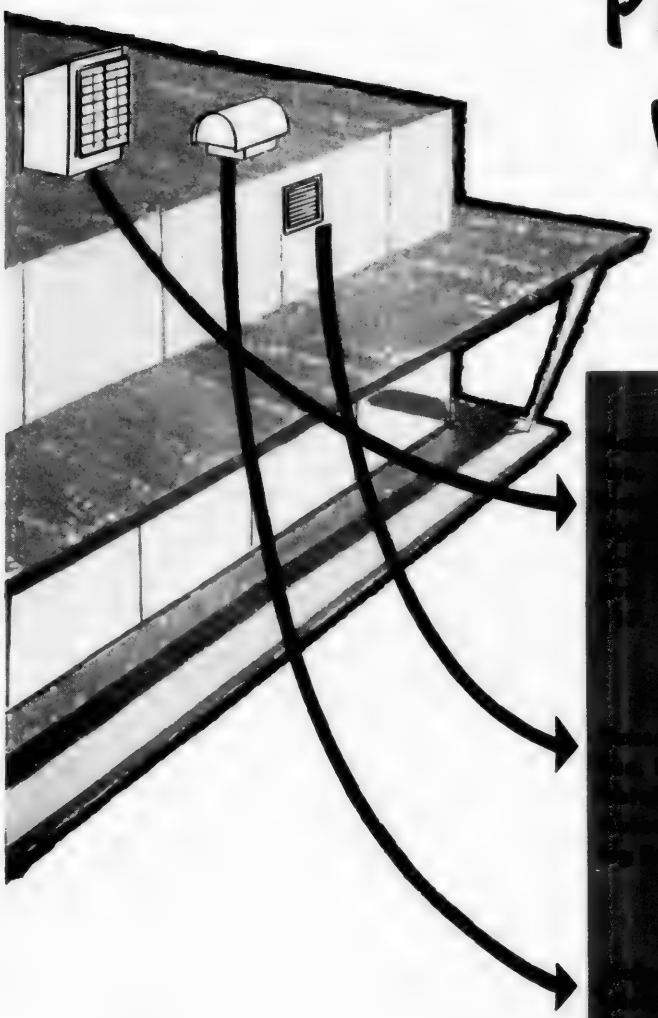
Since 1855—Crane Co., General Offices: Chicago 5—Local Service Everywhere Through Branches & Wholesalers

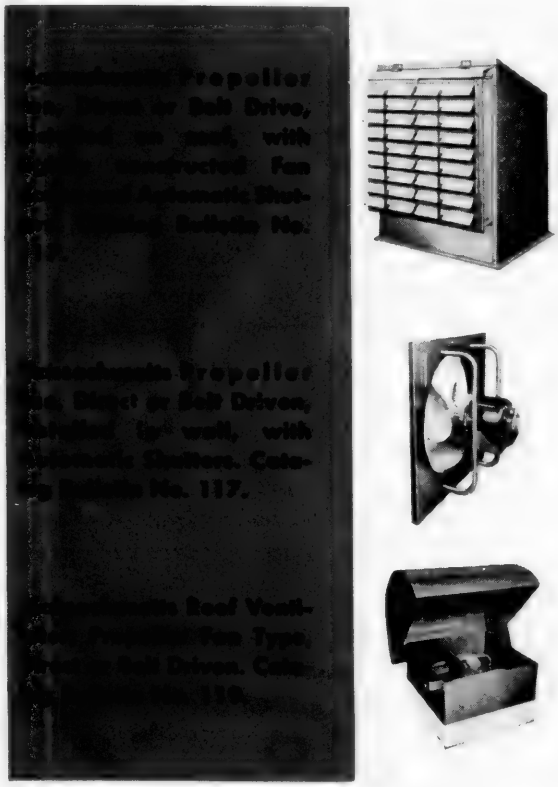
The MASSACHUSETTS Line

3 Types of Propeller Fan Ventilation

For Small to medium size buildings.★

Featuring Steel Venturi Type Inlet Orifice.





★ For heavy duty see Bulletin No. 124 Power Fixed Roof Ventilators.

The BISHOP & BABCOCK Mfg. Co.

DOUBLE-FLOW AQUATOWERS* ARE

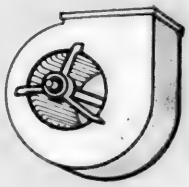
Original...

Marley Double-Flow Aquatowers, like all successful original products, have an invaluable advantage. They were designed to fill a definite economic need, not to secure a share of an existing market. And, drawing on the experience of hundreds of installations and on 35 years of specialization in cooling tower design, Marley constantly improves Double-Flow Aquatowers. Marley engineers are uninhibited, unconfined by tradition; they have a single objective — the finest low-silhouette cooling tower for the commercial-institutional capacity field. This is why Double-Flow Aquatowers continue to be the outstanding choice of engineers, architects and contractors on three continents.

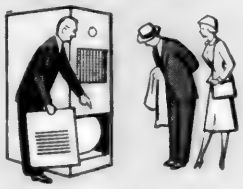
*Trademark Reg.

The Marley Company MARLEY *Kansas City, Missouri*

QUIETER TURNOVER HERE . . .



GIVES YOU QUICKER TURNOVER HERE . . .



RCR Type

RCSM Type

SUPER QUIET FAFNIR BALL BEARING RUBBER CYLINDRICAL CARTRIDGES

for
air conditioning
and
heating equipment

Super-quiet, maintenance-free performance, plus low cost and superior design features make these Fafnir Ball Bearing Units an excellent, economical choice for household air conditioning equipment — or for any equipment where quieter operation can increase sales appeal and customer satisfaction.

Fafnir Rubber Cylindrical Cartridges are equipped with RA-PP Type Super-Quiet Ball Bearings. These bearings feature balls and races specially-finished for extra-silent service. They are pre-packed with long-life lubricant, factory-filtered to reduce friction, wear, and noise, and to extend bearing life. Housed in electric current-conducting rubber grommets, they require no metallic grounding springs or clips.

Fafnir RCSM TYPE CARTRIDGES are specifically designed to interchange with other makes of ball bearing rubber-cushioned cartridges, while RCR TYPE CARTRIDGES, available in sizes to fit standard type sleeve bearing brackets, make replacement of ordinary sleeve bearing mountings easy and economical. Write for detailed information and specifications. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
SUPER QUIET
RA-PP TYPE
BALL BEARING

Balls and races specially finished for super-quiet performance.

Extended inner ring for greater shaft support.

Self-locking collar for easiest assembly . . . securely locks bearing to shaft with mere twist of wrist.

Patented Plya-Seals that positively keep dirt out, lubricant in. Bearing is pre-lubricated with correct amount of long-life, factory-filtered grease. Relubrication is never required.

SEND FOR THIS six-page bulletin containing detailed information, including dimensions and load ratings, of Fafnir's complete line of super-quiet ball bearings and rubber-cushioned ball bearing units.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Architect: Welton Becket, F.A.I.A. & Associates
General Contractor: Del E. Webb Construction Co.
Air Conditioning Contractor: F. B. Gardner Co.
Mechanical Contractor: Scott Co.

NEW CONCEPT OF HOTEL CONSTRUCTION known as total design integrates every element, from structural steel to the air conditioning system—Worthington air conditioning, of course.

New Beverly Hilton air conditioned by Worthington

Each room in the magnificent new Beverly Hilton has its own *individually controlled* air conditioner, consisting of a fan and coil unit. These fan and coil units supply year-round heating and cooling.

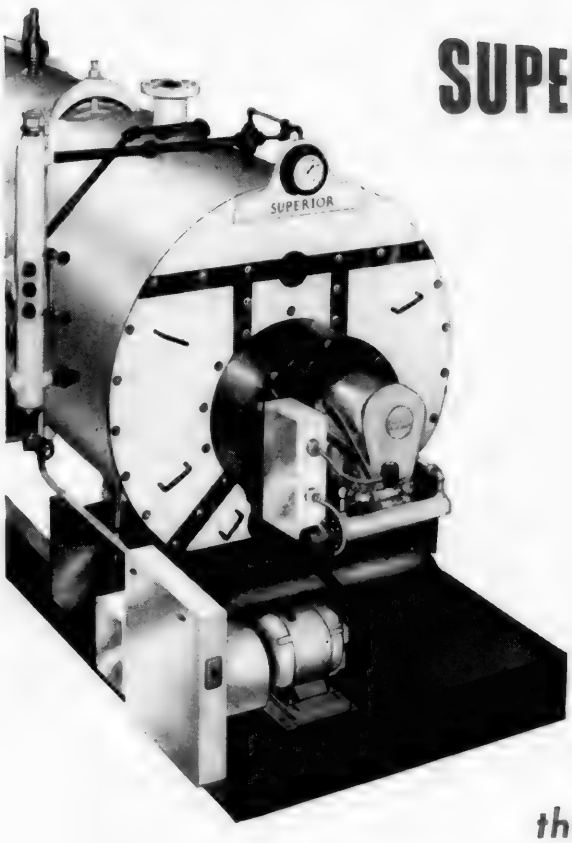
The entire 1000-ton system was selected after rigid tests under supervision of architect Welton Becket's staff. A pair of Worthington 400-ton centrifugal compressors and two 100-ton Worthington Packaged Water Chillers provide refrigeration for the complete air conditioning system. Worthington Corporation, Air Conditioning and Refrigeration Division, Section HP, Harrison, New Jersey. A-6-74

WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME

CLEANER
QUIETER
SAFER

. . . and built for years of extra service



SUPERIOR STEAM GENERATORS are the only packaged units with an integrated and built-in *induced* draft system (as shown at the left).

Superior's induced draft maintains a negative pressure in all 4 passes of the boiler as well as in the combustion chamber eliminating the need of spring-loaded pressure relief doors commonly used on forced-draft types, and eliminating the forcing of dirt, soot or combustion gases into the boiler room.

The multiple fans operating at lower tip speeds also eliminate much of the noise and the high speed "whine" found where high speed turbines are used.

A very important advantage of Superior's *induced* draft system is in the evenness of its draw across all of the tubes in the fourth pass. This even distribution of the hot gases eliminates the danger of overworked or burnt out tubes and adds years to the life of the boiler.

Superior Steam Generators are built in 18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. burning oil or gas or both.

Write today for Catalog 819F

the most rugged and dependable packaged fire tube boiler made . . .

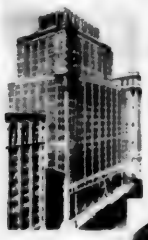
for performance you can **BANK** *on*

SUPERIOR
STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

"So Airtemp is Chrysler-Engineered—what's that to ME?"

AIRTEMP INSTALLATIONS



2 PARK AVENUE BLDG. New York City Consulting Engineers: Sears and Kopf. Mechanical Contractors: Kennedy, Scheidel and Young.

ROOSEVELT HOTEL Waco, Texas. Consulting Engineer: P. N. Vinther, Dallas, Texas.

CHRYSLER ENGINEERING MEANS QUIET OPERATION AND SATISFIED CLIENTS!

You can hardly hear Airtemp, it's so quiet! Chrysler engineering has made the difference, reduced the sound to a whisper. Airtemp has been manufactured to higher tolerances. Moving parts are dynamically balanced. Pressure lubrication reduces friction and wear. The result is air conditioning you can feel but not hear.

Quality engineering means a better product every time. It means lower installation and maintenance costs, continuous peak performance and more efficiency. It means happier, more satisfied clients.

Write today for complete information about Chrysler-Engineered Airtemp air conditioning.

Air Conditioning

FOR EVERY NEED IN HOMES, BUSINESS, INDUSTRY

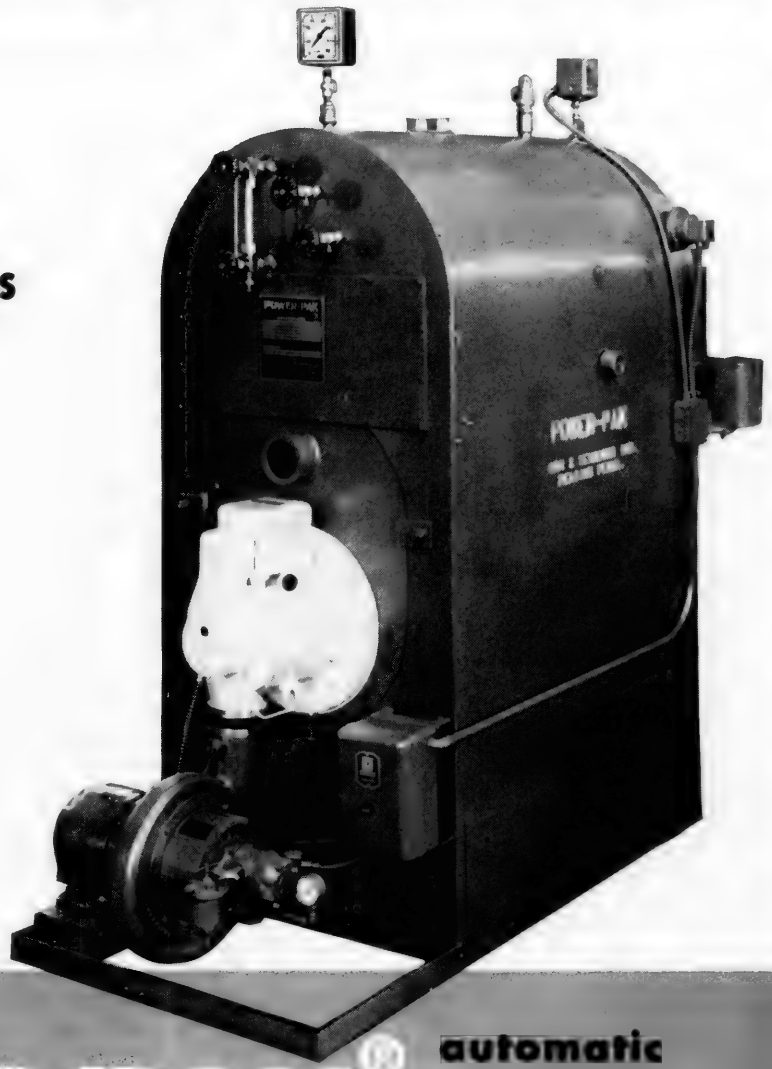
Airtemp CONSTRUCTION CORPORATION

SUBSIDIARY OF CHRYSLER CORP.

Airtemp Construction Corporation, Dept. AC-6-56.....Dayton 1, Ohio.

NEW

money-saving "package" for heating and hot-water service!



Money-saving advantages

- low complete cost
- completely factory-assembled
- saves floor space
- factory fire-tested
- operating simplicity
- rugged industrial burner
- water heating coils
- automatic controls
- quiet operation
- smokeless combustion
- easy over-all accessibility
- one-source responsibility for complete unit
- nation-wide factory-schooled service

O&S

POWER-PAK®

automatic packaged boiler

• Here is today's best buy in boilers for providing dependable, cost-saving, low-pressure steam or hot water heating for a wide variety of commercial and industrial requirements. Its many money-saving features make POWER-PAK the ideal boiler for heating loads up to 25 hp in schools, churches, motels, markets, stores, restaurants and taverns, bakeries, florists, garages, warehouses, launderettes, industrial plants or any other requirements within its capacity range. You can count on POWER-PAK for dependable, money-saving performance because it is built and backed by the builders of *Powermaster*—the modern packaged boiler with industry-wide recognition for quality and service satisfaction.

Investigate the advantages of POWER-PAK for your heating requirements. Send for Bulletin 1233 for more information on this new money-saving boiler.

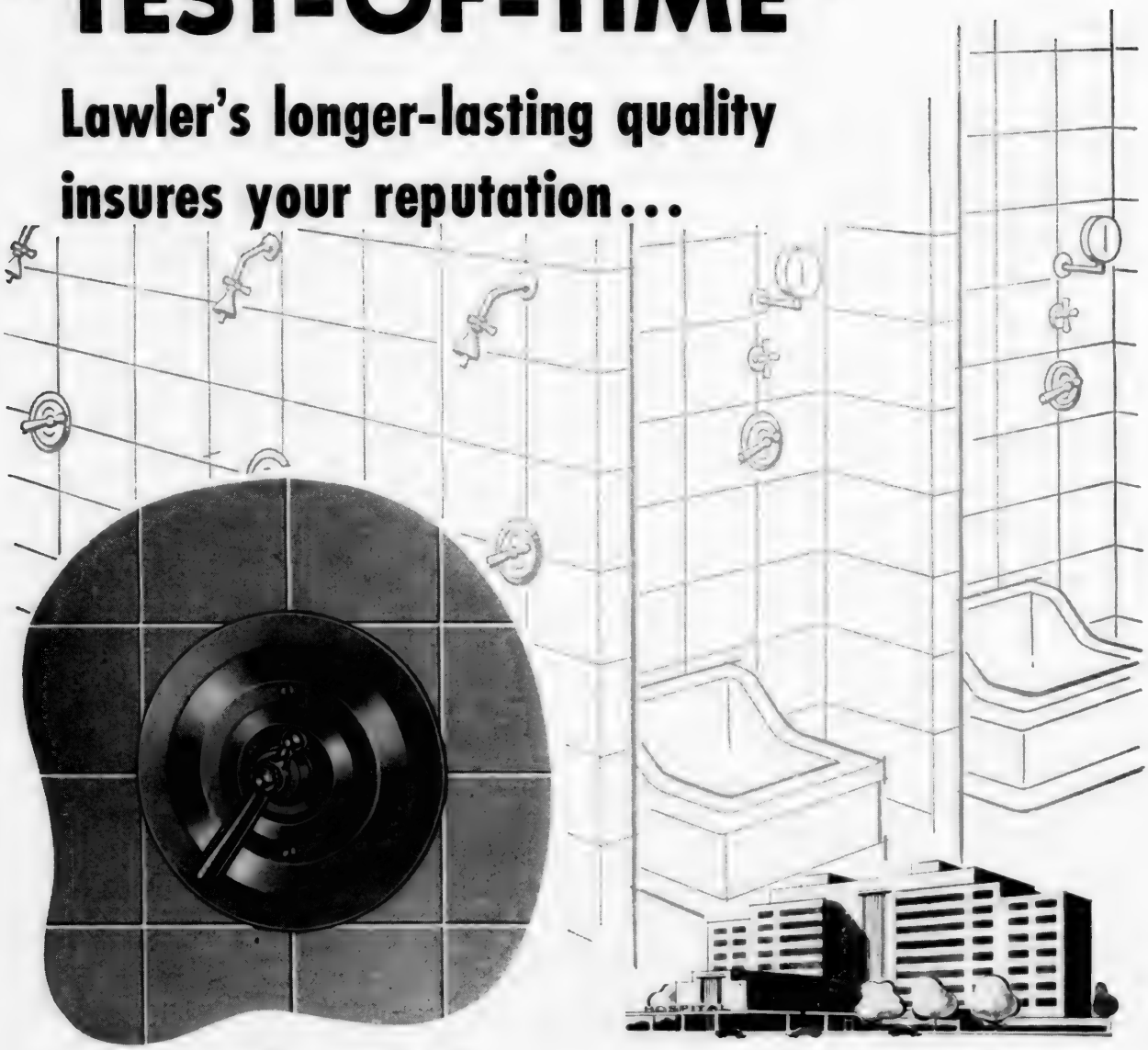
Builders of Dependable Boilers Since 1885

ORR & SEMBOWER, INC.

Morgantown Road, Reading, Pa.

"TEST-OF-TIME"

Lawler's longer-lasting quality insures your reputation...



NOW — NEW STREAMLINED DIAL PLATE REPLACES FOUR, HIDES ALL

For clean modern lines and neater installations, the NEW LAWLER "BCA" SHOWER MIXING VALVE leads the field. Valve, stops and checks with strainers now appear as one unit . . . *concealed behind the dial plate, yet readily accessible.* Exposed parts finished in polished chrome. Internal sliding parts are stainless steel.

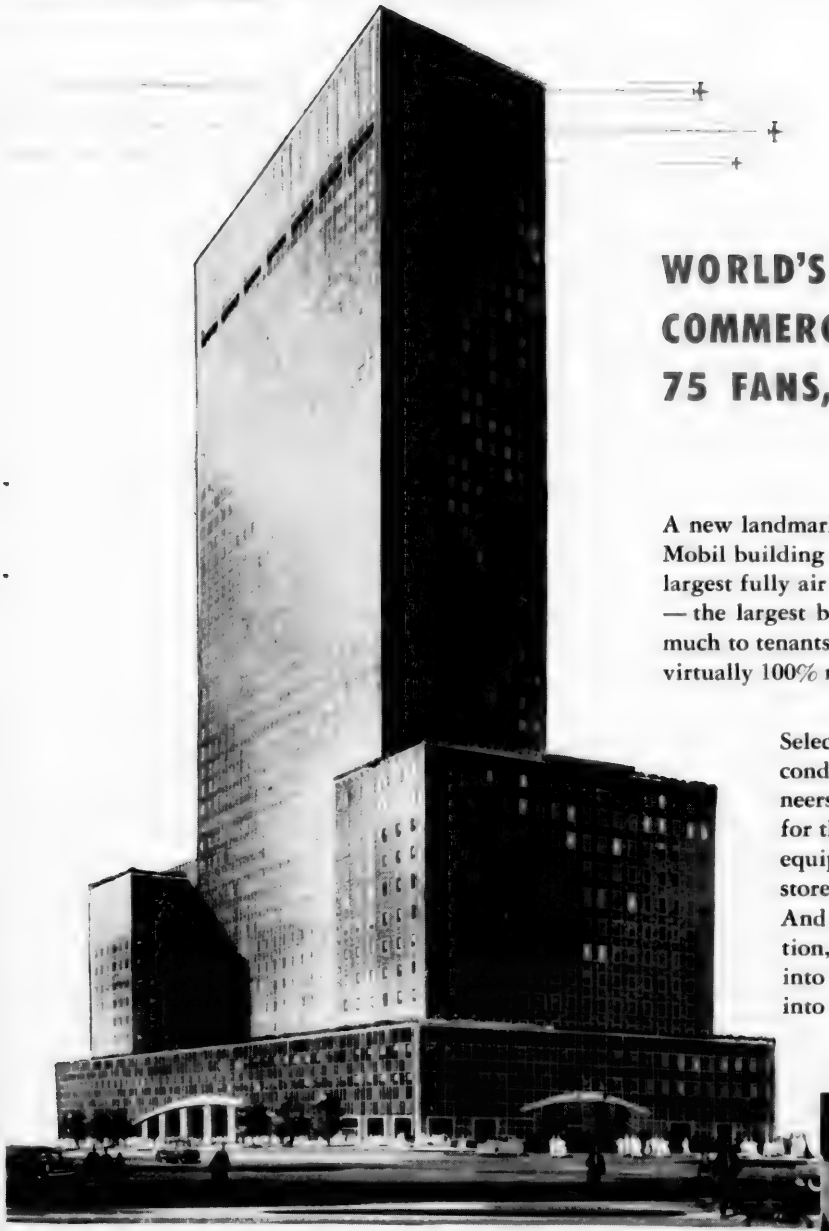
Lawler's "Performance-Tested" design combines pioneering experience with engineering leadership. The use of specially chosen metals assure YOUR customers years of positive, accurate temperature control with lowest maintenance cost . . . the best insurance YOUR REPUTATION can have.

"Performance Tested" for Longer Life

STEAM TEMPERATURE REGULATORS | SHOWER MIXING VALVES | WATER CONTROLLERS | TEMPERING VALVES

The Lawler Line **of Thermostatic Controls**

LAWLER AUTOMATIC CONTROLS, INC. 453 North MacQuesten Parkway, Mount Vernon, N. Y.

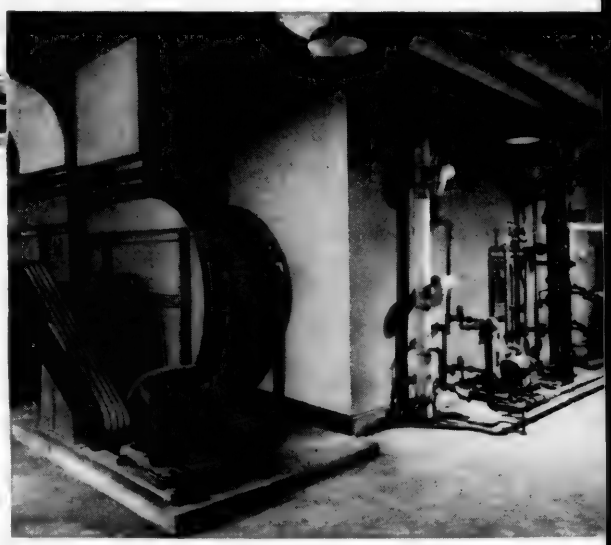


WORLD'S LARGEST AIR CONDITIONED COMMERCIAL OFFICE BUILDING USES 75 FANS, 22 CONDITIONING UNITS BY "BUFFALO"

A new landmark at Lexington and 42nd St., New York, the Socony Mobil building is a model for office buildings of the future. It is the largest fully air conditioned commercial office building in the world — the largest built in New York in a quarter-century. Offering so much to tenants, it is little wonder that its 1,300,000 square feet were virtually 100% rented before completion.

Selection of "Buffalo" for all the fans and many of the conditioning units reflects the confidence which engineers, owners and contractors have placed in "Buffalo" for the past 79 years. You will find "Buffalo" air handling equipment in outstanding plants, hotels, institutions, stores and public buildings throughout this hemisphere. And everywhere, you will find it performing to satisfaction, because "Buffalo" builds the "Q" Factor* of Quality into every unit. If you have a job for air, write "Buffalo" into the plans to insure the results you want.

New Socony Mobil building, New York City. Galbreath Corp., owner; Jaros, Baum & Bolles, Consulting Engineer; Kerby Saunders, Inc., Air Conditioning Contractor; Turner Construction Co., Builder.



"Buffalo" Type BL Fans handle air in Socony Mobil building. These fans (some of them 13 feet high) plus "Buffalo" Axial Flow Fans and "Buffalo" Shorthoy Ventilation Units move all the air. PCLW Dehumidifiers, Humidifiers and PC Air Conditioning Cabinets process the air for various zones.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

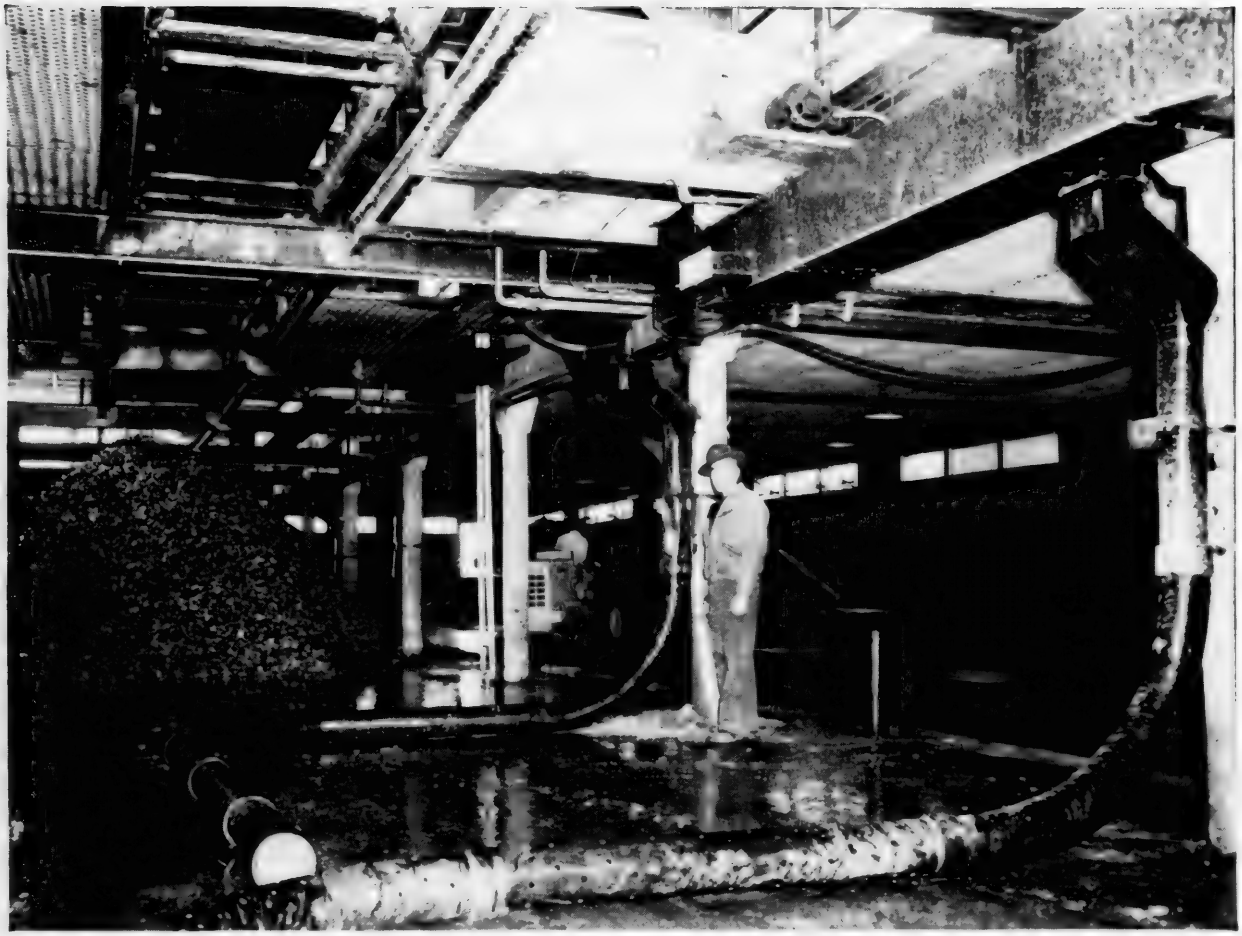
BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



HOW TO KEEP AN OYSTER COOL

The photo above illustrates a new and unusual use of air conditioning—believed to be the first application of its kind anywhere.

Oysters at the J. H. Miles and Company plant in Norfolk, Va., were formerly stored on ice overnight, still in their shells, until they could be shucked and packed the next day.

Now, however, they bask in luxurious air cooled comfort, thanks to a novel air conditioning system. As they are unloaded from the oyster boats, the bivalves are piled over perforated pipes on the storage room floor. Cold air is forced through the pipes and permeates the piles of oysters, keeping them cool and fresh until the next day's shucking. Cold air is also supplied into the space through grilles.

Two specially designed Marlo Ceiling Type Air Conditioning Units (top of photo) supply the cooling. Each unit has an air volume of 4000 CFM at 4" external static pressure. The units are arranged with stainless steel shaft and hot dipped galvanized casing, with 1" of waterproof insulation.

Baker & Co., Norfolk, was the air conditioning contractor on the project.

■ ***For any air conditioning problem—unusual or otherwise—you'll find a solution in the comprehensive line of Marlo quality equipment. Write today for information and literature.***

MARLO coil co.

SAINT LOUIS 10, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment Since 1925

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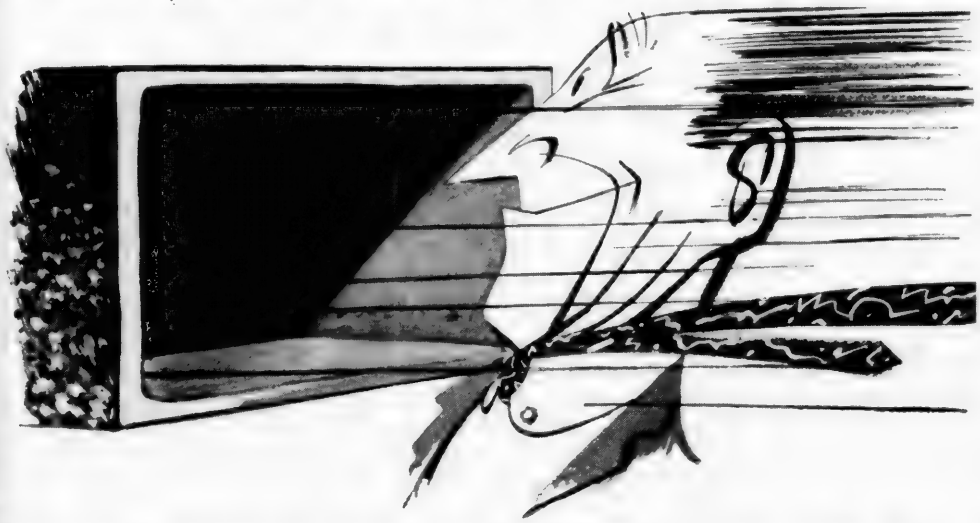
GUSTIN gb BACON

Line ducts with ULTRALITE #300



and move up to 7500 fpm of air—

***without* objectionable noise!**

***without* eroding the duct liner!**

***without* much more air resistance than you get from *bare metal ducts*!**

For performance, there is nothing on the market today like Ultralite #300 — the only spray-coated duct liner of long textile type glass fibers.

Ultralite #300 possesses the density that it takes to silence high frequency fan noise. Its long staple strength and spray-coating prevents delamination even in high velocity systems. And its .021 friction coefficient compares very favorably with .019 coefficient of unlined bare metal ducts.

Ultralite #300's performance in all air conditioning systems — low, medium or high velocity — can well mean the difference between a successful and an unsatisfactory job . . . may even mean a difference in the size of duct required to handle the flow of air! Get the facts today from your nearby Ultralite distributor whose phone number is listed in the adjacent column.

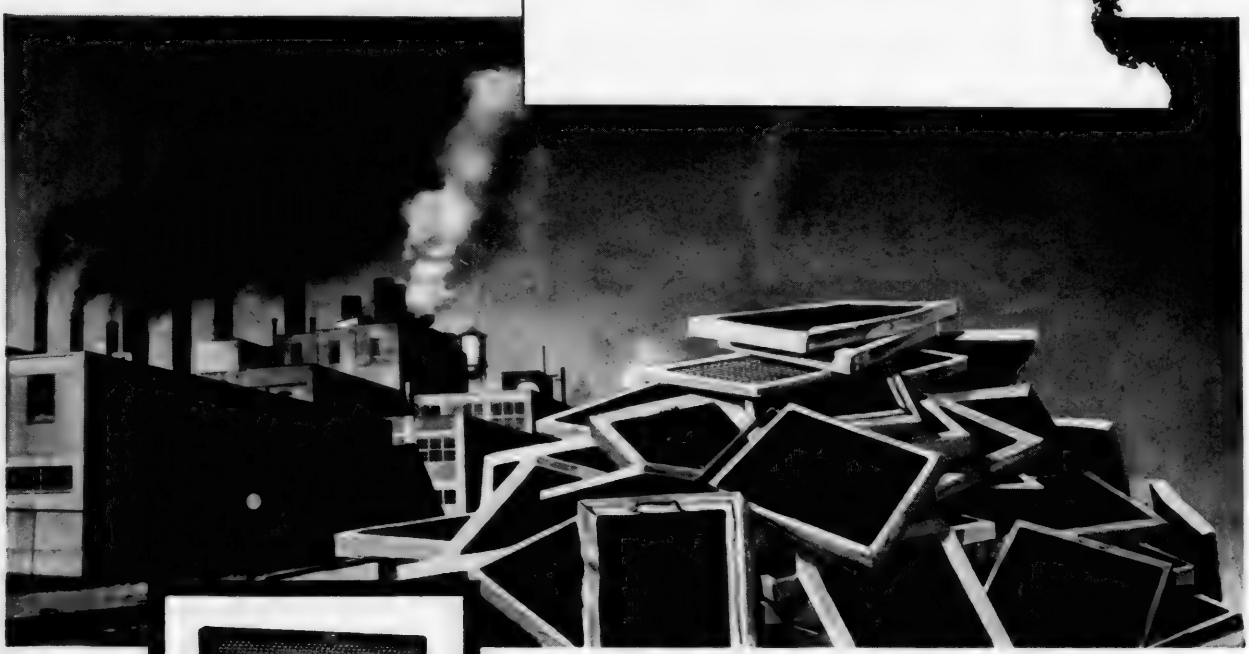
Write Today for New 8-Page Technical Brochure
"Ultralite Thermal and Acoustical Duct Insulations"

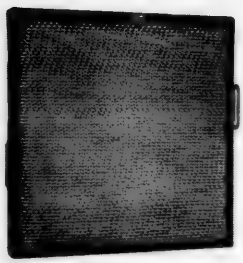
GUSTIN-BACON *Manufacturing Company*

Thermal and acoustical insulations • Molded glass fiber pipe insulation
Pipe couplings and fittings

222 W. 10th St., Kansas City, Mo.

HERE'S THE SEQUEL TO "...or equal"





Standard 2" FAR-AIR Panel Filter.

Send for your copy showing complete specifications on the FAR-AIR line of quality filters.

When you see this specification..."FAR-AIR® filters or equal" remember that these filters *have no equal.* Substitutes mean contributions to the junk pile and higher eventual costs, so it pays to install the finest—FAR-AIR.

In FAR-AIR you get filters that handle more air with greater efficiency. Because of their greater dirt-holding capacity, you save up to 60% in maintenance. The "lifetime engineering" of FAR-AIR filters with their heavier frames, reinforcing rods and other features, insures that each unit will continue to operate with replacements virtually eliminated.

Yes, you'll want to use FAR-AIR filters eventually, so why not install them initially. Write for complete catalog information to FARR COMPANY, P.O. Box 45187, Airport Station, Los Angeles 45, California.

ORIGINATORS OF FAR-AIR CERTIFIED FILTER SERVICE

FARR COMPANY

NO COMPROMISE ON QUALITY

Los Angeles, New York, Chicago

New Orleans

MANUFACTURED UNDER LICENSE BY FARR COMPANY MANUFACTURING LTD MONTREAL CANADA

Your first recommendation for automatically-fired boilers:

McDONNELL Feeder-Cut-Off Combination

Here's Why:

One way to safeguard an automatically fired boiler is to equip it with a low water fuel cut-off . . . but is this enough?

Well . . . the more deeply you dig into the causes of boiler trouble, the more firmly convinced you will become that every automatically fired boiler should be equipped, not just with "*something*" to safeguard it, but with *everything* modern skill and knowledge has to offer.

And *everything* means *both* a boiler water feeder *and* a low water fuel cut-off. You have them in their most advanced and dependable form in the McDonnell feeder-cut-off combinations illustrated here.

Of course some heating men will bring up the question: "Why both? Why do you make low water cut-offs if they are not enough?"

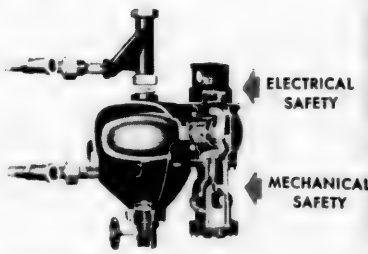
Our first answer is that we would not make low water cut-offs if they didn't do a *good* job, and we wouldn't make feeder-cut-off combinations if they didn't do a still *better* job. But the final answer goes back to the basic obligation of the heating man—the obligation to give the boiler owner automatic operation and the *maximum* safety available.

There are *some* conditions under which only a low water cut-off could save a boiler: extreme priming or foaming, for example, or a big leak in the system, or a failure of water supply.

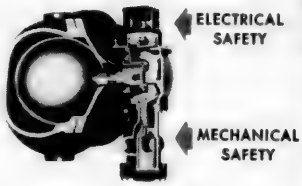
And there are *some* conditions under which only a water feeder could save the day: on a gas-fired job, for instance, if the electric gas valve failed to click, or on a stoker-fired boiler when a considerable firing continued after the blower was stopped—or perhaps a job placed on manual operation.

More conditions could be cited, but the fundamental point is: leave out either the feeder or the cut-off and you leave out *some* precautions.

Yes, as shown below, the feeder-cut-off combination gives both *mechanical* safety and *electrical* safety. It eliminates the pitfalls of manual filling. It "makes the boiler water level as automatic as the firing." Make it your first recommendation for all boilers. Ask for latest complete catalog.



For the smaller boilers —
No. 47-2 feeder cut-off combination for boilers up to 5000 sq. ft. Maximum steam pressure, 25 lbs.



For the larger boilers —
No. 51-2 feeder-cut-off combination for boilers above 5000 sq. ft. capacity. Maximum steam pressure, 35 lbs.

No. 53-2 feeder-cut-off combination for boilers of any size. Maximum steam pressure, 75 lbs.

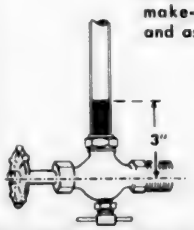
Remember — the same difficulties can occur in hot water boilers. So give them the same dual mechanical-electrical safety with feeder cut-off combinations. Use McDonnell No. 247-2, 51-2, 53-2.

McDONNELL & MILLER, *Inc.*, 3500 N. Spaulding Avenue, Chicago 18, Illinois

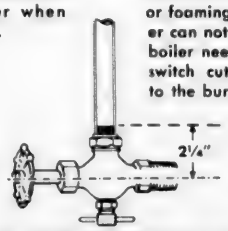
Doing One Thing Well

What a feeder cut-off combination gives you:

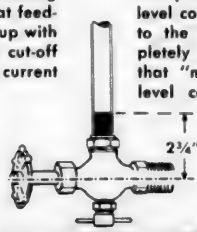
1 MECHANICAL SAFETY — Feeder keeps water level at safe minimum—feeds make-up water when and as needed.



2 ELECTRICAL SAFETY — If an emergency arises, such as extreme priming or foaming, so that feeder can not keep up with boiler needs, the cut-off switch cuts the current to the burner.



3 AUTOMATIC OPERATION — When the emergency has passed, the water level control is returned to the feeder. A completely automatic cycle that "makes the water level control as automatic as the firing."



Your Jobber Sells Them

McDONNELL *Water Level Controls*

Random Thoughts from a Filter Engineer

by C. W. Savitz

- **A FEW ELECTRONIC AIR CLEANER "FIRSTS"**
- **STRAIGHT FROM WHICH HORSE'S MOUTH?**
- **THE CASE OF THE OVER-RATED FILTER**
  (Automatic Curtain Division)

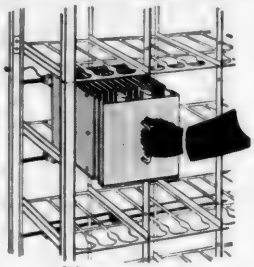
A FEW ELECTRONIC AIR CLEANER "FIRSTS"

In a product as long-established as Electromaze, the fact that its unusual design incorporated many "firsts" ordinarily wouldn't mean too much to the user. In the case of Electromaze, however, most of these features are still exclusive and explain why it is still today's outstanding electronic air cleaner.

Here are some of the features that, to the best of our knowledge, are Electromaze "firsts":

Electromaze has the first diffuser ionizing section and collector plate section built into one unit. Thus each cell is a complete filter that slides into its holding frame like a file drawer. Result, lower cost field assembly and greater ease in inspection and servicing.

Electromaze has the first automatic and semiautomatic washing and oiling unit in movable horizontal headers. Result, water and oil pressure is concentrated in a smaller space. Headers are out of the air stream. Electromaze was first to use dual ionizing wires for double protection against wire breakage. First to have quick bus bar disconnect so that individual cells can be removed instantly without affecting the rest of the system. First to use etched aluminum collector plates for better oil retention, first to have aluminum cells chemically coated for corrosion resistance. First to employ ionizing wire bracket assembly that can be removed by removing a screw.



Electromaze®

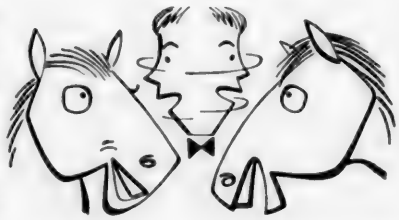
Not as sensational as the invention of the airplane, but to people who buy filters and have to worry about installation and maintenance costs, these "first" developments are rather important.

And these "firsts" promise other engineering "firsts".

STRAIGHT FROM WHICH HORSE'S MOUTH?

Like everybody else in industry, we rely on the technical magazines, journals and so on to keep up to date on what's going on. Who's doing what? Where are the markets for new products? Is anybody making that new product? And how good is it?

And by and large, we admire the job that most magazines do. We have one suggestion, though. We know that some articles originate as publicity releases. Fine. No one is better able to discuss a product and its performance than the manufacturer. But, when a magazine publishes performance data in its editorial pages, the source should be clearly indicated. A phrase such as "according to the manufacturer", tells the reader who is making the claim. They let him know which horse's mouth he's getting his facts from. And, if he chooses, he can make whatever allowance he thinks necessary for parental pride.



We feel it is undesirable for a magazine to jeopardize its prestige among its readers by accepting manufacturers' claims that it has not independently verified. As we said, we rely on magazines. But we hesitate to rely on magazines that pass data on without stating clearly whom they are quoting. After all human judgement is frail enough. Why should anyone want to assume responsibilities for anyone else's frailness?

THE CASE OF THE OVER-RATED FILTER

(Automatic Curtain Division)

Every viscous impingement air filter has an optimum operating velocity under a given set of conditions. Satisfactory performance can also be obtained, within limits, at velocities higher or lower than the optimum.

A good engineering approach to rating the capacity of a filter, especially the automatic viscous curtain type, is to select the optimum velocity so that the customer will have a margin of safety above or below this figure.

Sometimes, under pressure of competition, filter manufacturers eat into this margin of safety—uprate the filter's capacity either to make the price appear less or to fit into smaller space.

All would be well if the air flow pattern into the filter were equally distributed or if the ventilating air volume were exactly as specified. But all too often, such is not the case. Frequently air distribution is unequal. Many times the designer has been overly conservative in figuring duct losses. This permits more air to flow than the filter was designed to handle. The result is an overall lowering of filter efficiency and possibly oil entrainment.

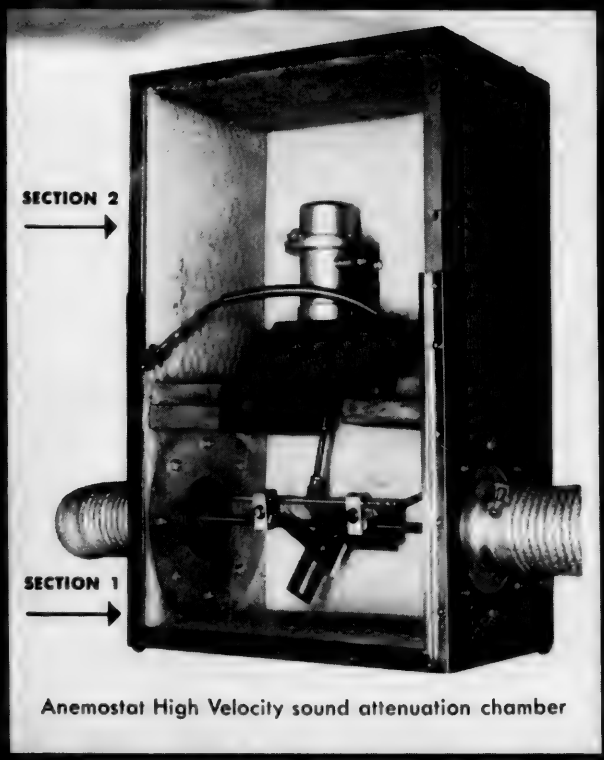
Our suggestion is that you make sure you have a margin of safety in the capacity of the automatic curtain filters you buy. Some types of automatic filters (and our Automaze is one of them) render excellent performance even when substantially oversized. While this costs a little more, it saves a great deal of trouble in the long run. The Air-Maze Corporation, 25000 Miles Rd., Cleveland 28, Ohio.

AFI MEMBER AIR FILTER INSTITUTE

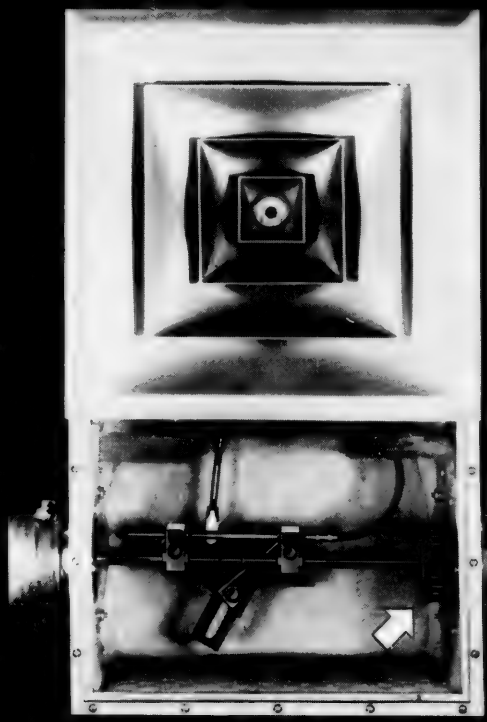
AIR-MAZE

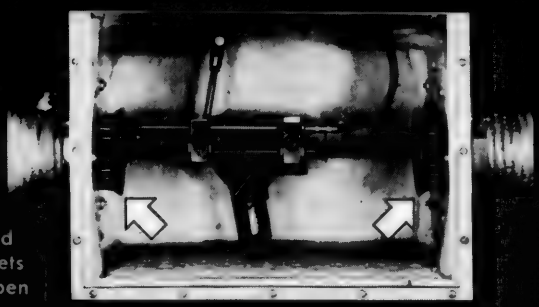
The Filter Engineers

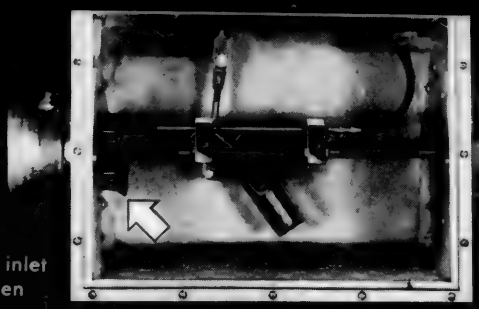
AIR FILTERS • SILENCERS • SPARK ARRESTERS
LIQUID FILTERS • OIL SEPARATORS • GREASE FILTERS



Anemostat High Velocity sound attenuation chamber


Hot inlet open in Section 1.
Anemostat in place covers Section 2


Hot and cold inlets 50% open


Cold inlet open

How to mix and diffuse high velocity air automatically

The Anemostat High Velocity sound attenuation chamber is divided into two sections. Both hot and cold air from the main risers enter Section 1, which is an acoustically lined blending chamber, in which the volumes of air are controlled by the Anemostat serrated rocket-socket valves. When the thermostat is set, the rocket-socket valves move slowly back and forth, thereby adjusting the volume of air supplied through the hot and cold inlets. The velocity of the air which enters Section 1, at from 3500 to 6000 fpm, is automatically reduced by expansion.

As the blended air meets the temperature requirements of the thermostat, it passes through a baffle arrangement into the acoustically lined Section 2 of the chamber, further reducing the db rating of the air.

The air then passes through the Anemostat Air Diffusers, where the aspiration effect causes mixing of room and supply air within the diffuser, resulting in further temperature equalization. The diffuser then delivers to the occupants of the room draft-free air at the desired temperature.

The Anemostat All-Air High Velocity distribution system offers other important advantages. It can be used with smaller than conventional ducts. It can be installed faster and at less cost. It requires no coils, thus eliminates leakage, clogging and odors. Furthermore, Anemostat round, square and straightline diffusers with high velocity units blend into a wide variety of architectural designs.

Write for 1956 New Products Bulletin and Selection Manual 50 to Anemostat Corporation of America, 10 E. 39 Street, New York 16, N. Y.

Anemostat: The Pioneer of All-Air High Velocity Systems

AC-1337

Sunray Building, Tulsa, Oklahoma. Architect: Hugh R. Humphreys; Consulting Engineers: Carnahan and Thompson; General Contractor: Manhattan Construction Co.; Equipment Contractor: Carl Moore Co.

D. C. Kennedy (left), special-service director of Sunray Mid-Continent Oil Co., and H. E. Kenslow, vice president of Anderson-Rooney Operating Co., which owns and operates Sunray Building.

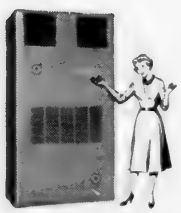
In Tulsa, weather news is made indoors!

The modern Sunray Building presents over 28,000 square feet of glass area to Tulsa, Oklahoma's blazing 100° summer heat and its frigid, below-zero winter climate.

To combat these unusual temperature changes, Anderson-Rooney selected American Blower air conditioning equipment. Result: ideal indoor comfort the year round, regardless of weather outdoors.

"Our American Blower equipment has been running continuously," says Building Engineer W. B. Reed, Jr. "Not once has it failed us in any manner. In fact, it has practically taken care of itself. We have exercised no maintenance, no repairs. About the only thing that we've done is to wipe the units down occasionally to keep them clean."

If *your* plans include air conditioning, it will pay you to talk to an American Blower sales engineer. He's backed by a full line of equipment for any size or type of installation. Call our nearest branch, or write us direct.



In addition to equipment for complete central systems, American Blower offers packaged air conditioners for offices, stores, small industrial plants, similar applications.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of AMERICAN-Standard

AMERICAN BLOWER

Air conditioning equipment for every business

NEW "SA" FLO-CONTROL VALVES

COMBINATION

...always the right valve for the job

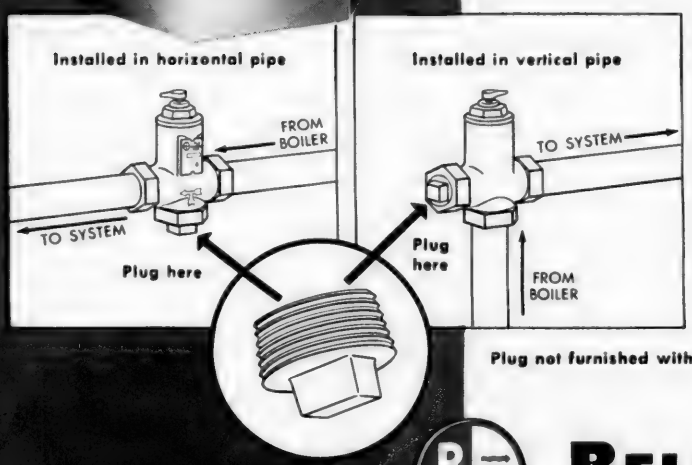
...simplifies stocking

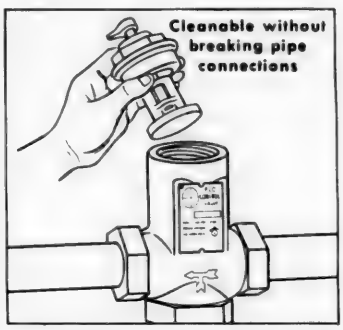
Another B&G advance in product design...for greater convenience in installing forced hot water heating systems! The new "SA" Straight-Angle Flo-Control Valve can be installed in either horizontal or vertical pipe lines—giving the installer wider latitude in meeting various piping problems.

The "SA" is available in sizes 1″ - 1¼″ and 1½″—replacing the same sizes in individual straight and angle pattern valves. They conform in every detail to the high manufacturing standards which have made B&G Flo-Control Valves known for positive, tight seating and dependable operation.

ALL B&G FLO-CONTROL VALVES *ARE EASY TO CLEAN!*

Whether "SA" type or regular angle and straight patterns, B&G Flo-Control Valves can be cleaned without breaking pipe connections. Just unscrew the top cap—lift out the valve mechanism—clean the valve—replace the cap.





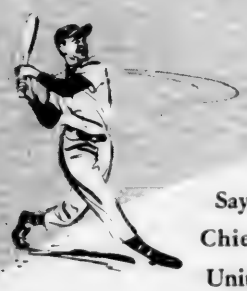
Plug not furnished with valve

BELL & GOSSETT
COMPANY

Dept. EJ-4, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, West Toronto

"You can't get a Better Boiler Box Score"



Says Stanley D. Loomis, Chief Engineer of The United Piece Dye Works, a leader in the field of textile dyeing, finishing and printing. Of course, he's referring to the C-E Package Boiler, Type VP—installed in the newest and most modern United Piece Dye Mill at Charleston, South Carolina. His box score for 1955 appears at the right.

SCORE CARD

AT BAT

3 shifts a day, 6 days a week without a single unscheduled outage.

RUNS

around the clock with a quick response to load change and an ability to sustain a high overload capacity while producing high quality steam.

HITS

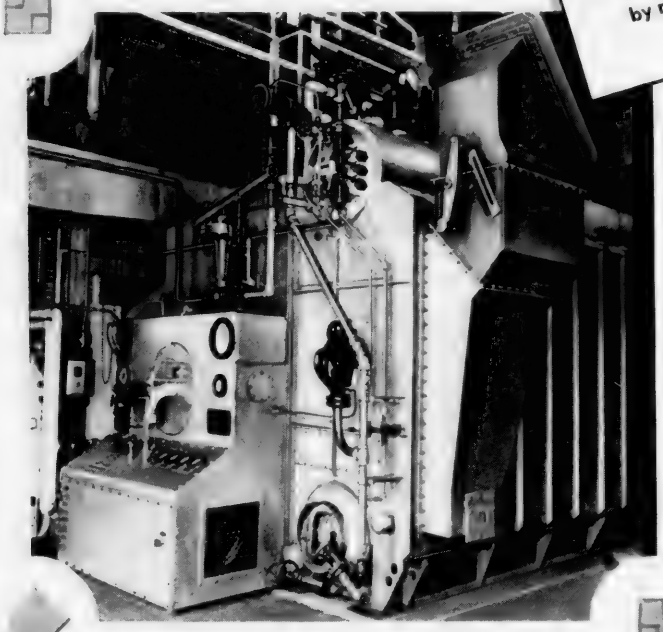
the performance mark. C-E's prompt service and complete cooperation matches the quality of the boiler.

PUT OUTS

of maintenance and repair bills are assured by the boiler's conservative design and built-in advantages. To date there have been no repair bills at all.

ASSISTS

in the continued full-production operation of the plant by meeting every steam need unfailingly.



Need a Package Boiler? See C-E! You can't get a better boiler box score.

B-9118

COMBUSTION ENGINEERING

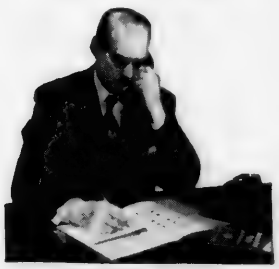
Combustion Engineering Building — 200 Madison Avenue, New York 16, N. Y.

CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

STEAM GENERATING UNITS • NUCLEAR REACTORS • PAPER MILL EQUIPMENT • PULVERIZERS
FLASH DRYING SYSTEMS • PRESSURE VESSELS
HOME HEATING AND COOLING UNITS • DOMESTIC WATER HEATERS • SOIL PIPE

C-E

SIMPLIFIES DESIGN



SIMPLIFIES BUYING

SIMPLIFIES INSTALLATION

Makes your work easier!

EVERYONE who specifies, buys and uses welding fittings and flanges has a mighty good reason for insisting on TUBE-TURN* products. *They simplify his work!* Being the world's most complete line, they *simplify piping design.* All available from one nearby source, they *simplify purchasing.* Of unsurpassed uniformity, they *simplify installation.*

These cost-cutting advantages are yours at no extra cost when you specify TUBE-TURN Welding Fittings and Flanges and buy from your nearby Tube Turns' Distributor. You get *more for your dollar* with this leading brand!

The Leading Manufacturer of Welding Fittings and Flanges

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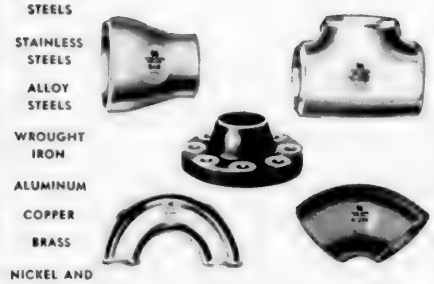
How TUBE-TURN Welding Fittings and Flanges

SIMPLIFY YOUR WORK

ENGINEERING

You can specify TUBE-TURN Welding Fittings and Flanges and know that you'll get the exact answer to your problem. The line includes all types in all piping materials, schedules and sizes. Also, Tube Turns offers you engineering assistance and helpful design literature.

CARBON STEELS
STAINLESS STEELS
ALLOY STEELS
WROUGHT IRON
ALUMINUM
COPPER
BRASS
NICKEL AND ALLOYS

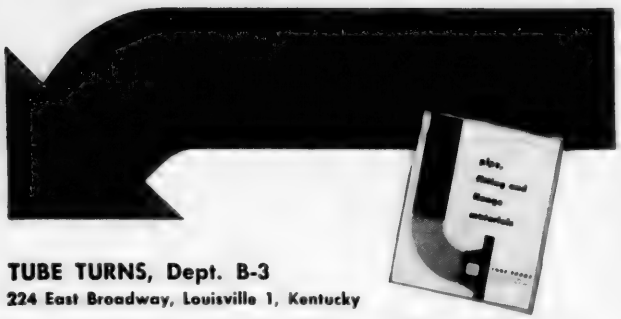


PURCHASING

Tube Turns offers you outstanding distributor service . . . local stocks, geared for fast service. You can depend on this source for all your needs in welding fittings and flanges. One order . . . one source saves purchasing time.

INSTALLATION

Welders are enthusiastic about TUBE-TURN products because they fit up true, and elbows can be cut to odd angles with perfect alignment. Rigid inspection and quality control by Tube Turns assures absolute dimensional accuracy and uniformity.



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Please send free copy of Pipe, Fitting and Flange Materials.

Company Name _____

Company Address _____

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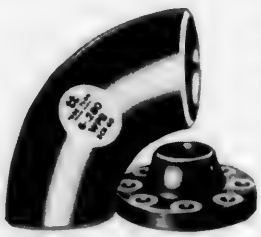
Your Name _____

Position _____

Available from your nearby TUBE TURNS' distributor



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LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

427 miles of heating dependability

ASSURED FOR N.Y. STATE THRUWAY!

FIRST... By Sarcotherm Weather-Compensated Control Systems for all 40 Toll Interchanges

AND NOW... By Sarco Heating Specialties for 23 Service Areas

ON THE NEW YORK STATE THRUWAY, there are now 23 restaurant-gas service areas and 40 toll interchanges along the 427 miles of this great vehicular artery...from New York to Buffalo.

Each of these service areas and toll interchanges has its own heating plant. Therefore, dependability of equipment is of vital importance...for faulty operation or breakdowns would mean heating headaches and call-backs all along 427 miles of highway.

That is one of the principal reasons for the installation of Sarcotherm Weather-Compensated Control Systems for the hot water heating of *all* 40 toll interchanges...and of Sarco Steam Heating Specialties for *all* the 23 service areas now completed.

For undivided responsibility on your installations, specify and order from one "Complete Line" source...SARCO-SARCOTHERM...heating specialties, temperature regulators, condensate and vacuum pumps, finned tube radiation, and weather-compensated control systems for steam and hot water heating. Write for catalogs.

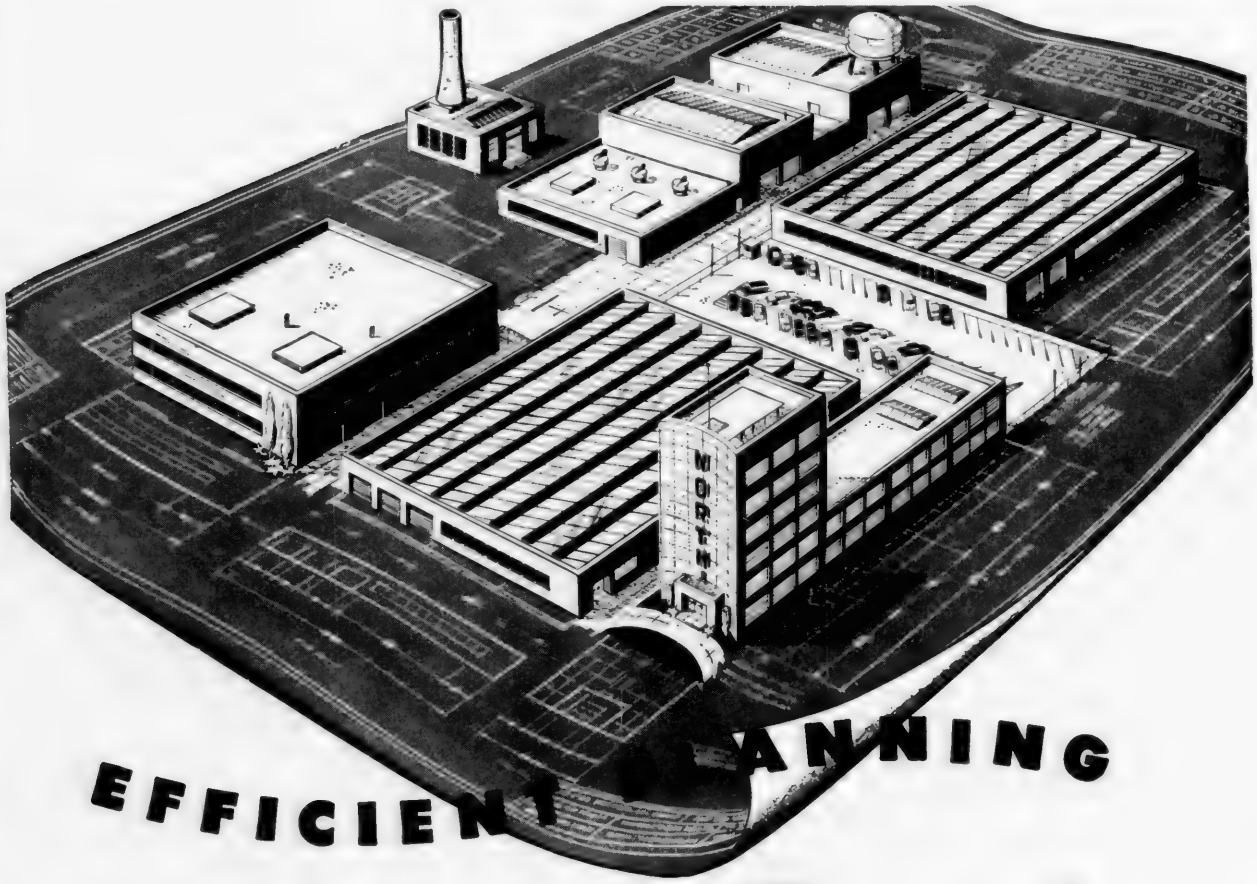
SERVICE AREAS—Architect: Eggers and Higgins. Consulting Engineers: Jaros, Baum & Bolles. Heating Contractors: Joseph Davis, Inc.; Mechanical Installations, Inc.; Harry Hoyle Contracting Co.

TOLL INTERCHANGES—Mechanical Engineers: Syska & Hennessy, Inc. Heating Contractor: Mechanical Installations, Inc.

SARCO

Sarco Company, Inc. • Sarcotherm Controls, Inc.
Empire State Bldg., N. Y. C.

2162-B



EFFICIENT PLANNING

Starts with RIC·WIL

● Early planning with a RIC-WIL field representative on central heating or air conditioning systems will mean less work later on. Custom engineering and prefabrication of RIC-WIL units offer quick, efficient installation. RIC-WIL's engineering service with forty-five years experience in the Insulated Piping Field is available for *early* planning and consultation.

Write or phone your nearest representative or send for the illustrated RIC-WIL catalog.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC·WIL INCORPORATED

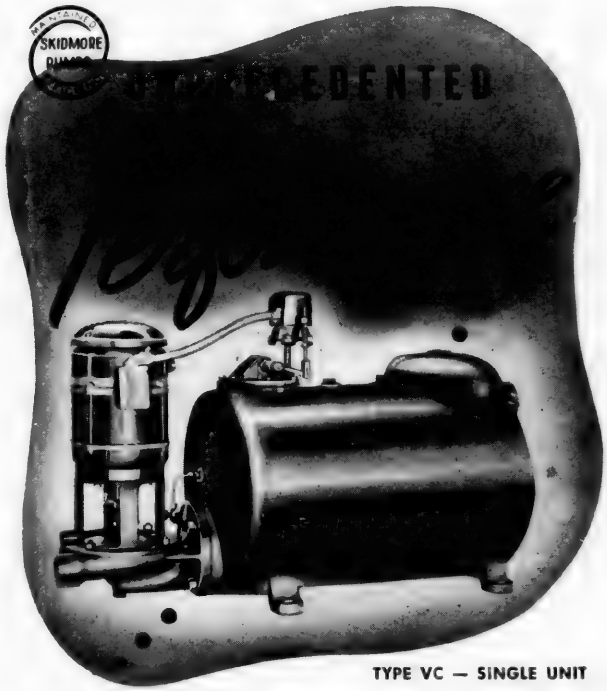
PREFABRICATED **INSULATED PIPING SYSTEMS**

BARBERTON, OHIO

ELIMINATE YOUR HEATING PUMP PROBLEMS—FOR GOOD!

call in a Skidmore Specialist

There's no need for heating engineers, architects or contractors to worry these days — they know the record of performance and continuous service of Skidmore Pumps throughout the years — they know that from this one source (The Skidmore Heating Pump Specialist) you can get experienced council on every type of pump installation. Tailored to your specific needs — you eliminate your pump problems "for good." There's a Skidmore Specialist in every principal city — call him today!



TYPE VC — SINGLE UNIT

The Skidmore Type VC Condensation Pump and Receiver has low inlet connection . . . operates quietly . . . impeller is bronze centrifugal enclosed type. Especially designed for handling hot condensate, entire unit can be removed for inspection or repair without disturbing piping connections. Skidmore Pumps are furnished in either single or duplex type according to installation requirements.

For complete information write for SKIDMORE VC Bulletin No. 10-B.

TYPE UV CONDENSATION PUMP

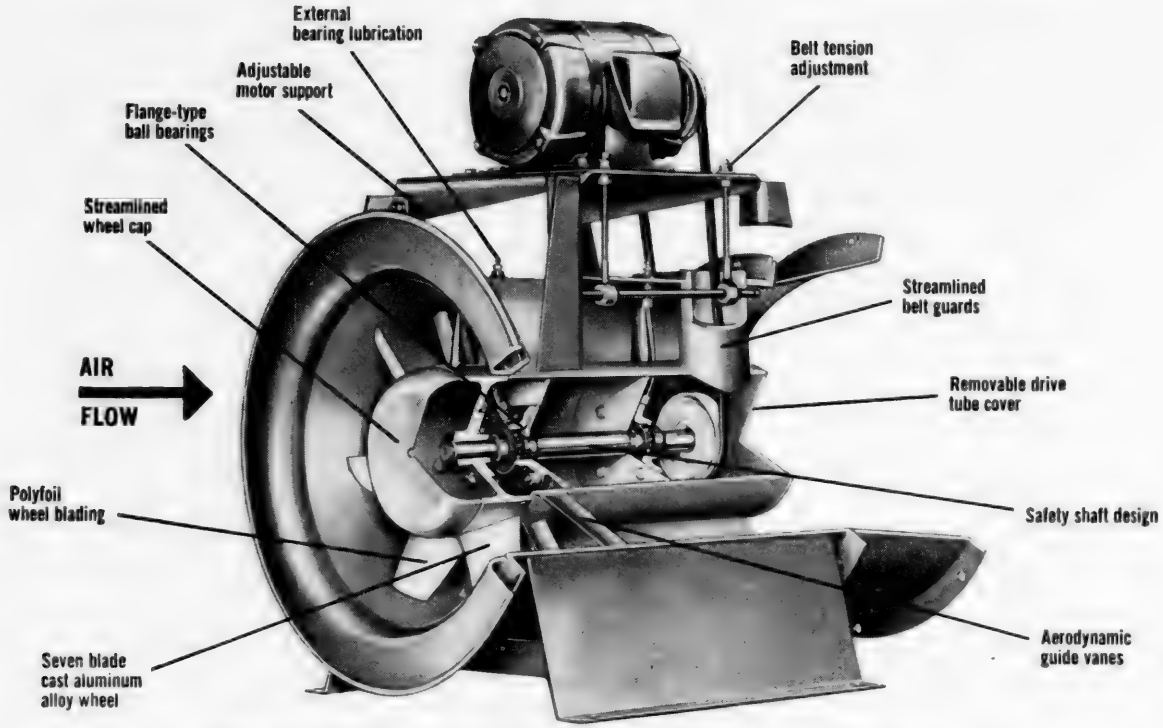
Where returns are too low to permit the operation of horizontal type pumps — the Skidmore UV Pump performs very satisfactorily. Consists of vertical pump and motor unit with float and float switch mechanism mounted on sump type receiver unit. Write for Bulletin No. 19-B. Also furnished in duplex unit.

TYPE "UV" SINGLE UNIT

SKIDMORE PUMPS — **SKIDMORE CORPORATION** ST. JOSEPH, MICHIGAN

NEW Improved Westinghouse Axial Flow Fans

for Industrial air, fume, vapor handling jobs!



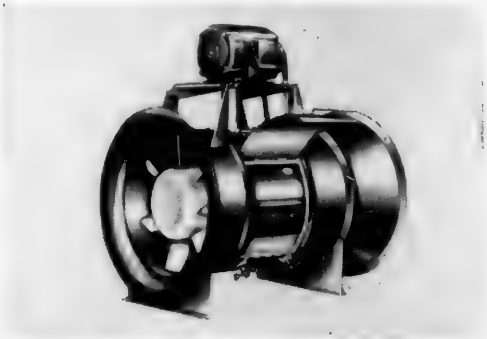
CUTAWAY VIEW OF WESTINGHOUSE AXIFLO® VANEAXIAL FAN FOR GENERAL APPLICATION.

COMPLETE NEW LINE

With: volumes from 1,700 to 100,000 CFM—static pressures up to 3¼"—14 sizes, Vaneaxial or Tube Axial, direct-connected or V-belt driven, with wheel diameters from 15" to 72".

- **Space Saving** . . . compact Axial Flow design permits installation directly into duct work.
- **Improved performance** . . . non-overloading horsepower feature permits use of smaller motors.
- **Least maintenance** . . . rugged practical construction insures continuous trouble-free operation.

For complete application service, call your nearest Sturtevant Sales Engineer, or write Westinghouse Electric Corporation, Sturtevant Division, Dept. 15F, Hyde Park, Boston 36, Mass.



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Cadott School

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Considering that most modern schoolroom construction costs average well over $30,000 per classroom, the low cost of the Cadott School is outstanding.

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3. **NEEDS NO HOUSING OR MECHANICAL SHEATHS**: no mixing, special handling or equipment.
4. **ONLY NEEDS NORMAL PIPE SPACING**: for multiple pipe or cramped conditions.
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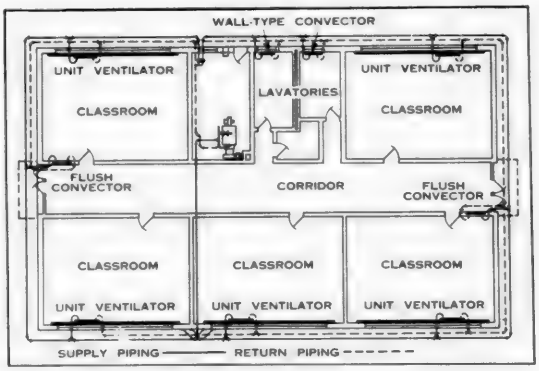

Cadott School floor plan

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remove even microscopic airborne particles

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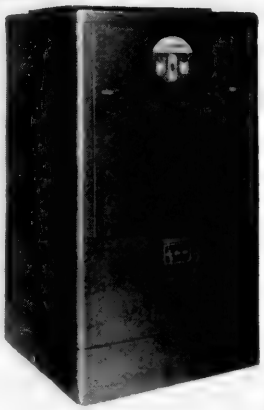

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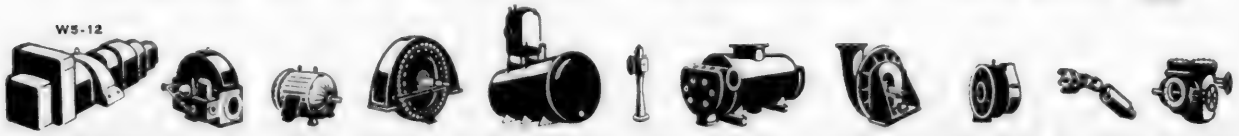

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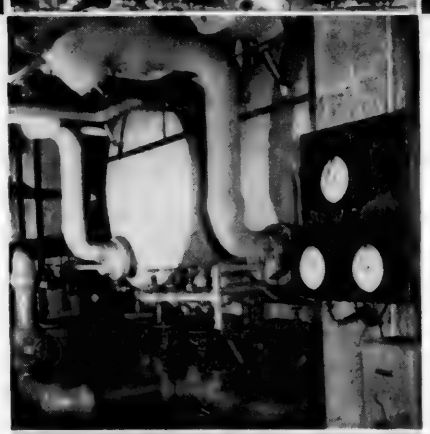

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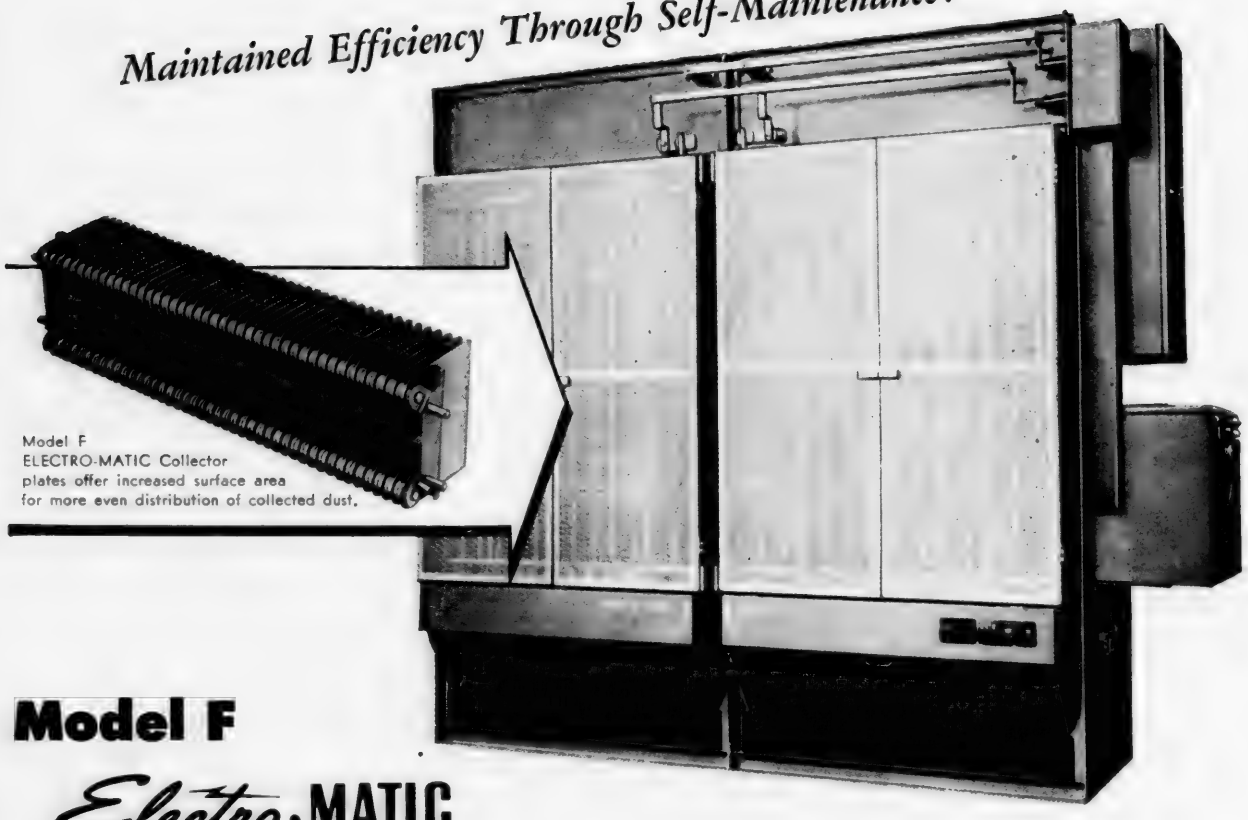

Model F
ELECTRO-MATIC Collector
plates offer increased surface area
for more even distribution of collected dust.

Model F Electro-MATIC

Delivers Uniformly Clean Air, Continuously, Around the Clock

WANT a continuity of clean air that won't vary in quality from one day, month or year to another? It's yours with the Model F ELECTRO-MATIC—the new electronic precipitator whose continuous high efficiency is assured through constant self-cleaning.

The cleaning efficiency of the Model F ELECTRO-MATIC extends over a wide range of particle sizes, from smoke to largest air-borne materials. Its "capacity for work" is increased, too. Newly designed collector plates increase surface area 53% to further reduce possibility of dust build-up and, at the same time, slows down air velocity between plates by 25%.

But here's the payoff! Unlike most other filters, ELECTRO-MATIC's efficiency can't taper off due to the accumulation of dust. Continuous self-cleaning action keeps collector plates in constant fighting trim. There's no time out for washing down with hot water. No need for extra sewer or water connections. ELECTRO-MATIC maintains its own rigid housekeeping schedule without regard to clock or calendar.

Yes, if performance is the payoff, the Model F ELECTRO-MATIC is definitely today's finest electronic filter. For complete product information, call your local American Air Filter representative, or write for Bulletin 250.

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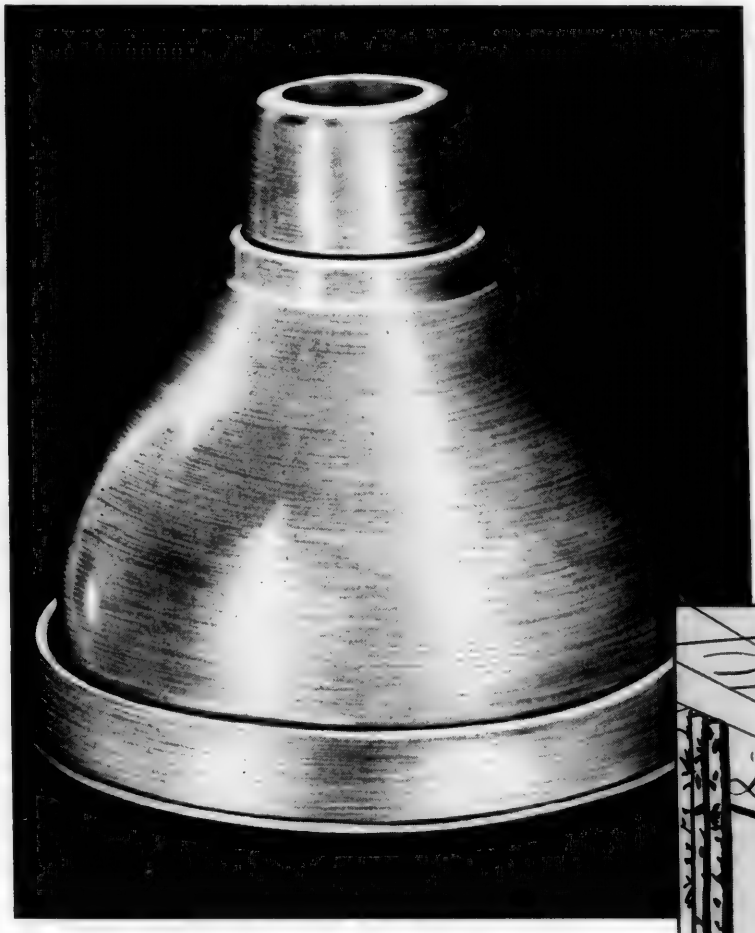

Our challenge stands

—anything that can be made of steel sheets can be made of

WHEELING

SOFTITE®

Galvanized Sheets

Believe it or not, this galvanized recessed ceiling light reflector housing was made by spinning. *"Impossible,"* you say? *"Can't be done with ordinary galvanized steel"?*

You are right! It *isn't* made of ordinary galvanized steel.

It's made of Wheeling SOFTITE, the tightest-coated galvanized sheet yet produced. So tight it won't chip, crack, flake or peel no matter how severely it is formed. It even takes *spinning* in its stride. In fact, *anything* that can be made of steel sheets can be made of Wheeling SOFTITE.

That's SOFTITE . . . made by the same company that developed Cop-R-Loy, the original copper-bearing steel pipe . . . and DUCTILLITE, the original cold reduced tin plate. Now SOFTITE, the ultimate in ductile, tight-coated galvanized steel sheets . . . a product of Wheeling Steel Corporation, Wheeling, West Virginia.

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For faster, easier pipe-racking, use versatile UNISTRUT® channel

Look how quick, easy and economical it is to install racking with UNISTRUT steel framing:

(1) Cut UNISTRUT channel to length;
(2) slide in the UNISTRUT nut;
(3) tighten with a wrench. That's all!

Better still, you get everything you need in the complete UNISTRUT line—channel, clamps, hangers, concrete inserts, rollers, or any other accessories your installations require.

Think how this advanced method can cut your costs! No drilling, welding or riveting. No fussing to get exact slope or pitch—UNISTRUT framing is completely adjustable. And it's easy to alter or add to the installation any time—the UNISTRUT system is extremely flexible.

Here is the foolproof, economical method for superior support of steam, gas, heavy water, light conduit or air-conditioning lines. Find out about UNISTRUT framing now!

Write Dept. V-6 for 78-page Catalog No. 700, giving complete information.

UNISTRUT framing supporting unit heater—a tricky job made easy through horizontal and vertical adjustability of UNISTRUT.

UNISTRUT framing—with UNISTRUT concrete inserts—supporting heavy water and sludge lines.

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U. S. Patent Numbers 2327587 2329815 2380379 2363382 2345650 2541908 2405631 2696139 Other Patents Pending

100 TON BARRIER

Crashing the 100 ton barrier

with KRAMER

UNICON

in semi-tropical climate

UNICON SUCCESSFULLY MET THE TEST THROUGH THE SEVERE SUMMER OF 1955

You, too, can crash the big tonnage barriers with UNICON, the industry's finest remote-type air-cooled condenser. Put Kramer's 18 years of "treasured know-how" in the proper use of air as a condenser coolant to work for you.

Photo of Kramer UNICONS mounted on roof of Handy-Andy Supermarket in San Antonio, Texas, used with 100 ton air conditioning system. Supplied through United Supply Co., of San Antonio and installed under the direction of Harold Vogt.

Write for Bulletin U-210-L

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KRAMER TRENTON COMPANY
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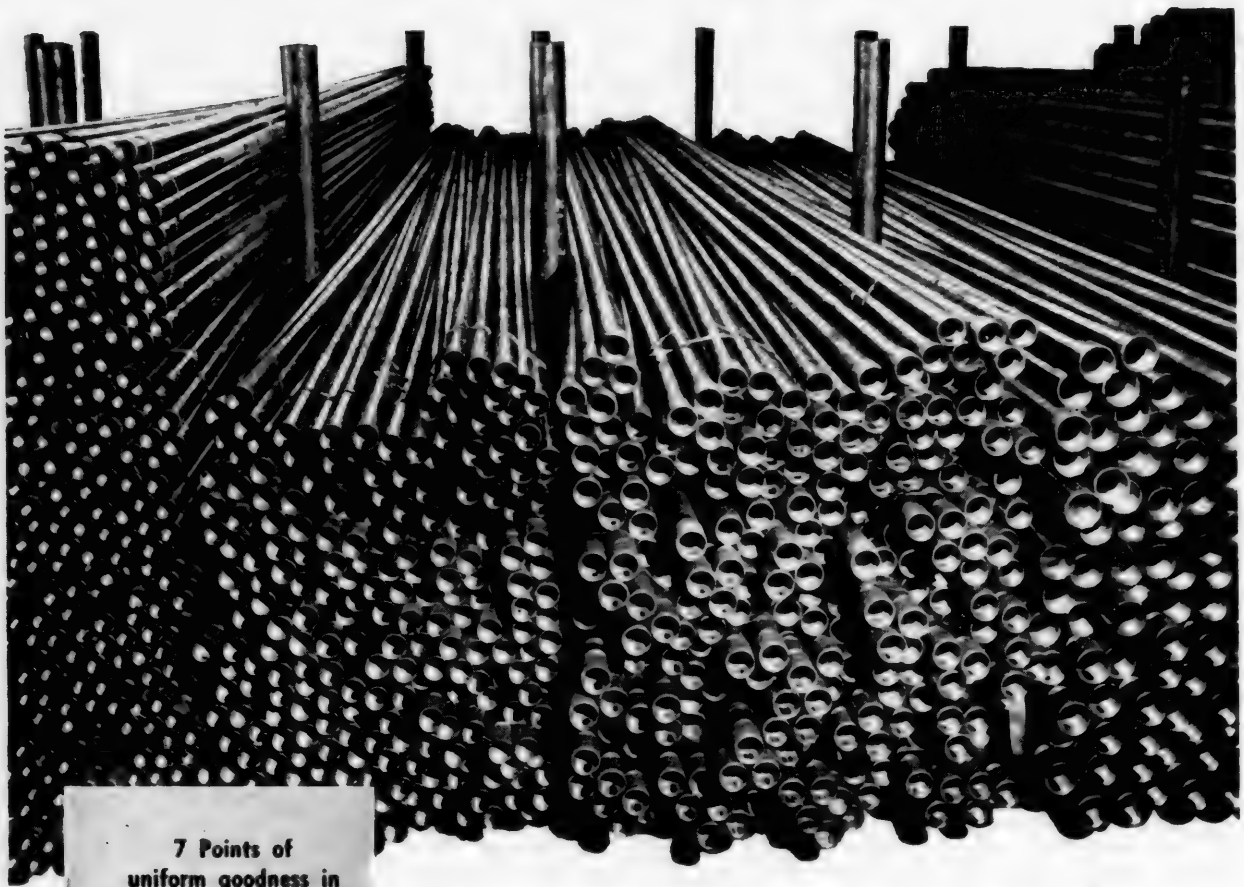
UNIFORM LENGTHS OF YOUNGSTOWN PIPE

make your job easier, quicker

. . . yet more efficient



7 Points of uniform goodness in YOUNGSTOWN PIPE

- uniform ductility
- uniform lengths
- uniform threading
- uniform weldability
- uniform wall thickness and size
- uniform strength and toughness
- uniform roundness and straightness

You may compare the importance of uniform lengths of Youngstown Pipe with having the right tool for a job . . . the right nut for a bolt . . . the right washer for a fitting. There's no lost motion. The length you specify is the length you get.
Combine this with the 6 other points of uniform goodness in Youngstown Pipe and add the fact that Youngstown is made only of the finest steel, quality controlled from ore to finished product, and you have a real prize winner! Be sure to specify Youngstown on your next order.

Youngstown PIPE

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THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

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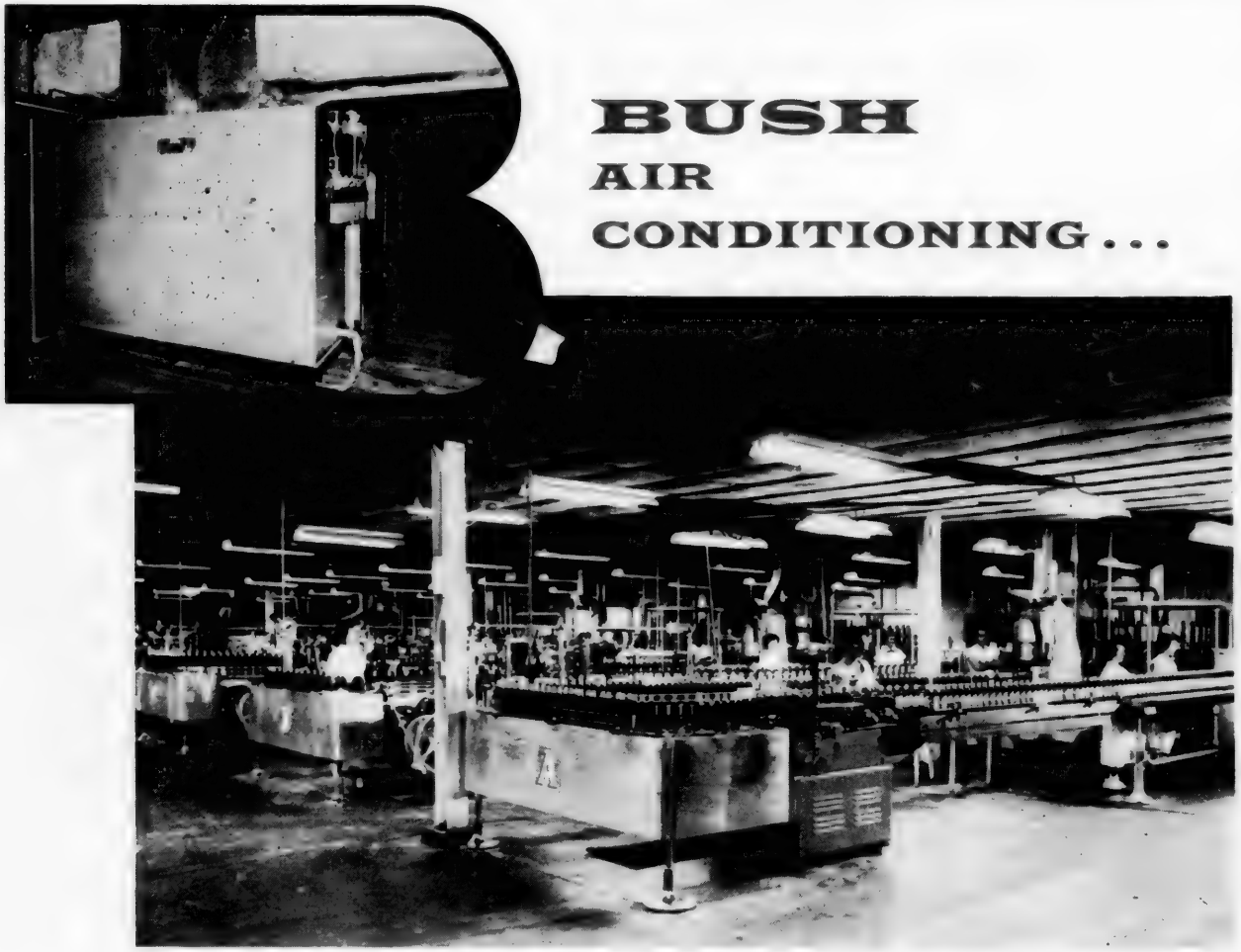

BUSH AIR CONDITIONING . . .

Handling FOUR-FOLD Job at Ultra-Modern GALLO Winery

A BUSH Vertical Air Handling Unit provides both product temperature control and comfort conditioning . . . handles both cooling and heating requirements in the ultra-modern bottling room at E. & J. Gallo Winery, Modesto, Calif. Face and by-pass damper sections, mixing box assembly and filter section permit flexibility and close control of the conditioned area.

Whatever *your* air handling requirements, there's a BUSH unit to meet them. Available in vertical floor-mounted or horizontal ceiling-hung models in capacities from 2.5 to 90 Tons . . . with a wide selection of accessory equipment to exactly meet any special needs. Models from AH10 to AH32 incorporate famed Inner-Fin extra-efficiency coil construction — patented BUSH exclusive.

Request catalog #710 containing complete specifications on Bush Air Handling Units.

BUSH

PRODUCT APPLICATIONS

New, Unusual, or Ingenious Uses of Equipment and Materials

Conducted by WM. B. FOXHALL, Associate Editor

Air Diffuser Features Germicidal Lamp

PROBLEM: At the University of California Bacteriological Research Center, a system for maintaining germ-free supplied air used a germicidal lamp installed in the air duct of the diffuser. Air in the duct was travelling from 1000 to 1500 fpm, and it was found that this velocity did not allow sufficient time of exposure to kill bacteria with the certainty that was required in the laboratory.

SOLUTION: An air diffuser manufactured by Pyle-National Co. of Chicago features wide-area diffusion at low velocity. Working in cooperation with General Electric and Westinghouse, who manufacture germicidal lamps, a diffuser was arranged with two lamps installed directly in the low velocity stream. After several experiments, the engineers installed a reflector opposite the lamps inside the diffuser so that killing rays were directed on the valve which is used to reduce air velocity ahead of the perforated ceiling panel.

RESULTS: After the reflector was installed, the percentage of bacteria killed was increased from 85 to 99%. A special cleaning arrangement keeps the lamps at peak efficiency.

Hot Water Supplements Air System

PROBLEM: A residence built a few years ago in metropolitan Chicago was equipped with a forced air heating system, but it was never possible to heat the basement recreation room satisfactorily even though outlets were provided on the under side of ducts located on the basement ceiling. Furthermore, the addition of a new room to the back of the house called for an extension of the main heating system. The cost of a larger furnace would have been considerable and would have included knocking out large sections of walls to introduce new air ducts.

SOLUTION: A small separate circulated hot water system was installed supplying baseboard radiation along the outer walls of both the recreation room and the new addition. A small hot water boiler was placed next to the existing furnace and small holes were drilled through the walls to accommodate a single circuit of copper tube. A thermostat in the recreation room operates a Bell & Gossett booster pump to provide heat when needed. Another thermostat in the new addition controls a second booster pump.

RESULTS: Both a new heating requirement and an older heating problem were solved by the addition of a small separate system.

Cooling Towers Salvage Process Coolant

PROBLEM: At the plastic manufacturing plant of Michigan Molded Plastics, Inc., Dexter, Mich., certain processes were using water at a rate of 60 million gallons a year. Much of this water was used merely as a coolant to draw heat away from molding machines. While the cooling water was not affected chemically, it was heated to a temperature which made it impractical to recirculate it either back to the machines or to other processes. The water was purchased from city mains at an annual cost well over $2,000.

SOLUTION: The general manager of the company and a representative for Acme Industries, Inc., Jackson, Mich., studied the problem and decided to use cooling towers in an attempt to salvage some of the water. Actual refrigeration of the coolant was not necessary because water with a temperature up to 80 deg F could be used in the plant. Two Acme cooling towers were installed at ground level near the building.

RESULTS: The towers keep the water at a desirable temperature and sharply reduced the cost of city water formerly consumed. Company figures show that water consumption during two equivalent quarterly periods dropped from 14,525,400 gallons of city water at a cost of $2,335 to 3,532,960 gallons at a cost of $576. The units are expected to save about $7,000 in yearly operating cost.

Plastic Pipe Warms Garage Floor

PROBLEM: Mechanics in the Chicago suburban garage of the La Grange Cab Co. complained that winter backaches and chilled feet were the result of cold floors in the garage.

SOLUTION: When a new garage was built, a radiant heating system using Crane polyethylene plastic pipe was installed using 6000 feet of pipe in ¾- and ½-inch diameters on 6-, 12-, and 18-inch centers. The pipe was rolled out and wired over a gravel base and wire mesh, then covered by a 4-inch concrete slab floor. Maximum water temperature is maintained at 120 deg F.

RESULTS: Garage working areas are maintained at 70 deg while the warm floor provides comfort for the type of work involved. The installing contractor found the plastic pipe easier to install and lighter to handle. A two-man crew finished the installation in four days. Maintenance of company cabs and buses is easier because ice and frozen mud are melted off the chassis. Engines are easier to start.

INSIDE STORY:

Why a Heat Exchanger Poses for an X-ray

This technician is giving a clean bill of health to a completed weld on a P-K heat exchanger. Like the x-ray of your chest, this x-ray picture is designed to pick up flaws before they have a chance to become harmful.

Pinholes, lamination, slag inclusions, and all other symptoms of failure are ruled out by this process, which is used to scrutinize the "inside" of *every weld*. Such radiographs are indispensible in manufacturing pressure vessels that will meet every test of time and use. Each x-ray is checked by a representative of the Hartford Steam Boiler Inspection and Insurance Company —for further insurance that every P-K heat exchanger meets or exceeds the rigid standards of the 1952 ASME Code for Unfired Pressure Vessels.

But weld x-rays at P-K represent only a *precaution*. They don't speak for the fact that all P-K welders are ASME qualified for a total of more than 50 types of welding procedures—meaning that the likelihood that flaws will occur at all is minimized. Nor can you see in an x-ray photo the incredibly careful design and calculation that goes into every P-K pressure vessel, to assure that it will be *thermally* and *physically* correct in every way.

Add this all-important knowledge of thermal design to P-K's fabricating and testing procedures, and you have what makes P-K heat transfer equipment different —and better—than all the rest.

Like proof? We'd be delighted to receive your inquiry. The Patterson-Kelley Co., Inc., 960 Burson Street, East Stroudsburg, Penna. Offices in principal cities.

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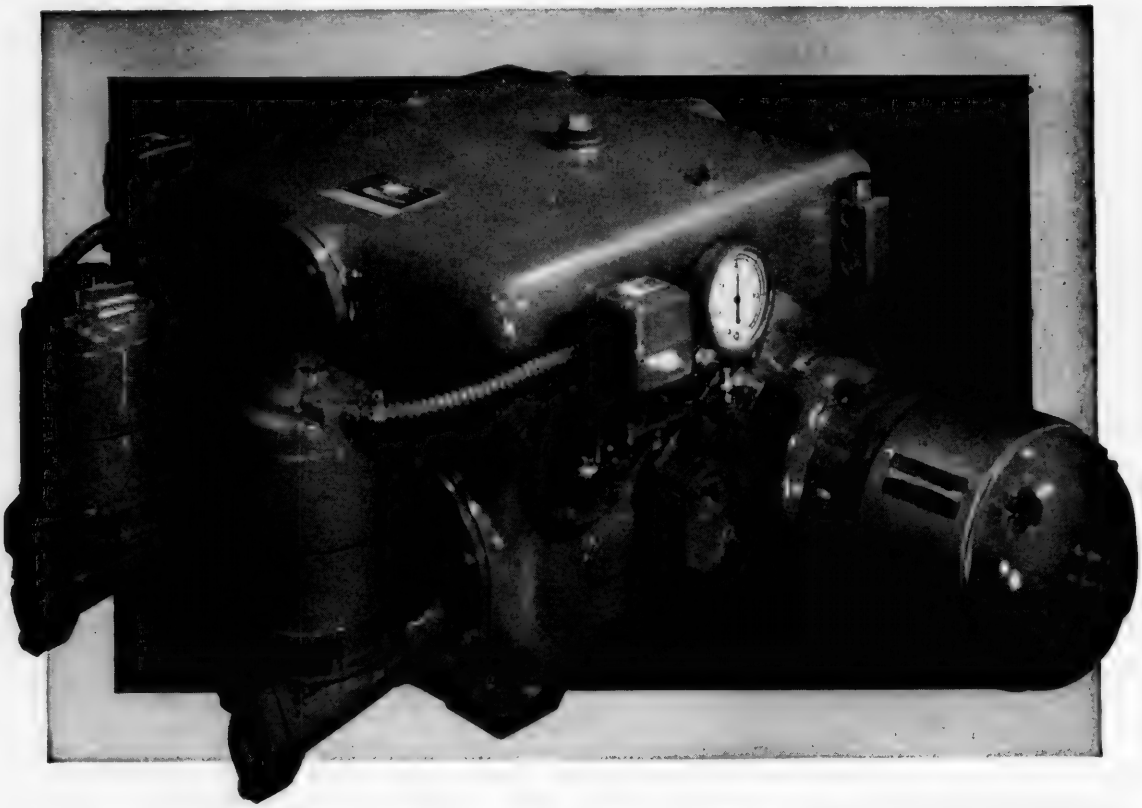
Twin Shell Blenders • Autoclaves • Pilot Plants • Heat Exchangers • Ribbon and Double Cone Blenders • Lever Lock Doors

THIS NEW VACUUM HEATING PUMP IS SIZED TO ACTUAL JOB REQUIREMENTS



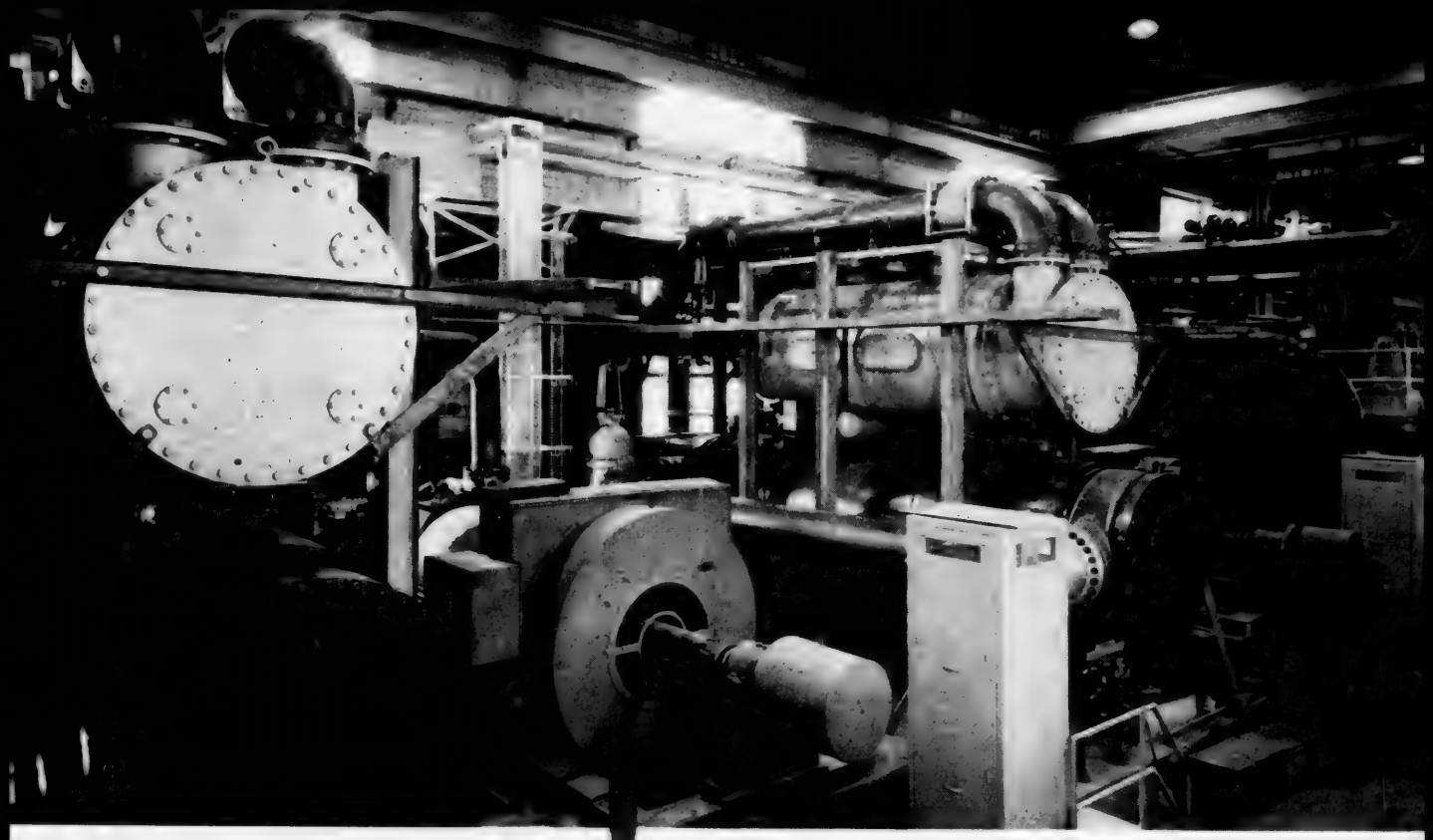
It's the Nash CSM

No longer is it necessary for the Engineer to accept a vacuum heating pump with air and water capacities based inflexibly upon square feet of equivalent direct radiation. With the flexible Nash CSM he can provide for proper air capacity in accordance with his judgment and experience. For the individual capacities of the separate pumps on the CSM may be varied within a wide range, without buying an oversize receiver and oversize water pumps.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low, returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

NASH ENGINEERING COMPANY
438 WILSON, SO. NORWALK, CONN.



Design of a Central Refrigeration Plant for U. S. Capitol Hill

J. W. BARRETT and A. M. LAUKAITIS

Project Manager Limited Partner

Guy B. Panero Engineers, New York, N. Y.

Expansion of existing central refrigeration facilities on Capitol Hill will ultimately bring into existence one of the largest comfort cooling refrigeration installations and district chilled water distribution systems in the world.

THIS summer the first two of four new 2200 ton centrifugal compressors will be put into service to cool the buildings on Capitol Hill in Washington, D. C. This will be the completion of the first stage of a project to modernize and expand the capacity of the existing central refrigeration plant serving the United States Capitol and other buildings in the vicinity of the United States Capitol, all operated under the jurisdiction of the Architect of the Capitol.

Authorization for the modernization and improvement program is contained in Public Law 413, passed by Congress in 1949. The improvements authorized in this bill included the expansion of the existing refrigeration plant facilities from 4,800 tons to a total installed capacity of approximately 8,800 tons and the addition of new distribution piping in a new walk-through tunnel. The legislation required all work to be performed under the direction of the Architect of the Capitol. The buildings served by the new tunnel include the Annex to the Library of Congress, the Supreme Court Building, the First Street Wing of the Senate Office Building, the Library of Congress and the Additional Senate Office Building.

The existing facilities to be expanded and improved upon, were completed in 1938 and they have been in continuous operation since that date. These facilities provided 4,800 tons of refrigeration capacity to furnish chilled water for the air conditioning systems in the United States Capitol, the Senate Office Building, and the

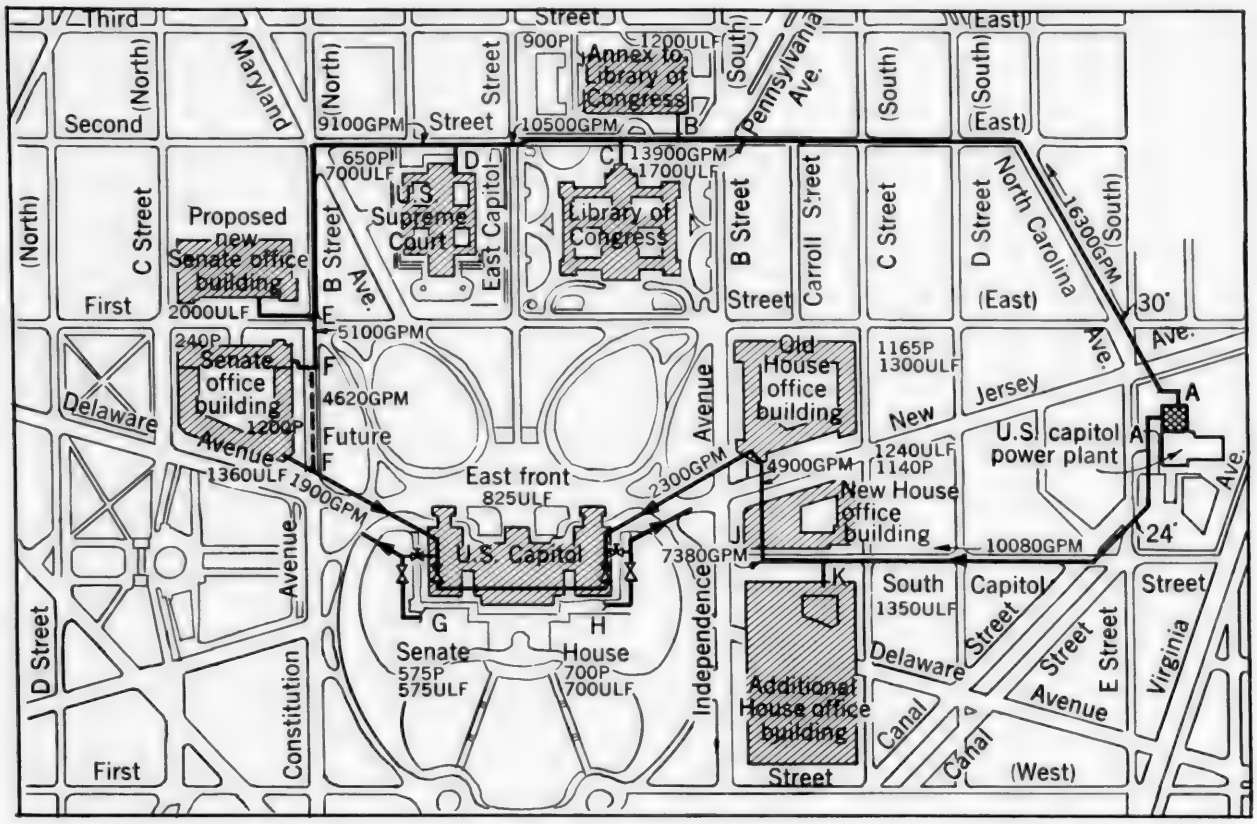


Fig. 1. Layout of Capitol cooling system. Figures at buildings refer to present and ultimate loads. Gpm shown are utlimate loads.

two House of Representative Office Buildings. The refrigeration equipment installed at that time consisted of six 800 ton reciprocating compressors using dichlorodifluormethane as the refrigerant. Each compressor is driven by a direct connected 1,000 hp, 6,600 volt, 275 rpm, 25-cycle synchronous motor. The condenser water is taken from the Anacostia River and pumped approximately one mile to the condensors. The chilled water distribution system is housed part way in a walk-through tunnel and then in pedestrian passages between buildings. The supply and return chilled water pipes are 24-inch size in the section of tunnel to the first building and then reduce in size so that the last building is served by 12-inch pipes.

The new central refrigeration plant will consist of four 2200 ton centrifugal compressors, each driven by a 2500 hp, 900 rpm, 4160 volt synchronous motor, with space provided for two additional machines. Chilled water will be circulated by two 8800 gpm circulating pumps each driven by a 700 hp motor. The new section of chilled water distribution piping consists of two 30-inch pipes running in a walk-through tunnel of approximately one mile in length. The old section of distribution piping will remain connected to the central plant.

Planning the Job

The initial step in planning was to establish the design criteria, about which the entire engineering concept of the design would develop. In this instance there were a number of completely firm criteria, fixed by law, and several others established by the Architect of the Capitol and ourselves.

The starting point of the project was the existing refrigeration plant containing six 800 ton machines, two chilled water pumps, two condensor water booster pumps and all the necessary auxiliaries and accessories normally required in a plant of this type. This equipment was contained in an extension to the Capitol Power Plant measuring approximately 120 feet by 75 feet and 35 feet high.

The decision to install the new refrigeration equipment within the limits of the existing structure was based on economy and other considerations. In addition, it was mandatory, from an engineering point of view that a portion of the available space within the existing structure be reserved for foreseeable future capacity needs.

The long range planning of the Office of the Architect of the Capitol, as indicated by the future loads shown in Figure 1, established an ultimate future load of 13,170 tons.

The necessary capacity to serve existing buildings and the additional Senate Office Building presently under construction, totalled 8600 tons. Therefore, it was decided to install the authorized 8800 ton capacity and provide space for two additional machines to handle the ultimate load of 13,170 tons. Piping facilities were designed for the ultimate load in order to preclude extensive changes at a later date.

In the design of the new equipment it was necessary to duplicate the existing 40 deg leaving water temperature, to avoid costly changes in the air conditioning systems of the buildings on the original central refrigeration system.

The overall project included among other items the

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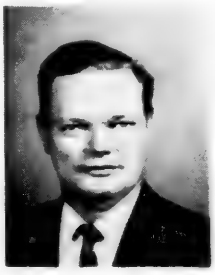

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construction of the walk-through tunnel from the Capitol Power Plant under 2nd. street, S. E. and N. E. terminating at the First Street Wing of the Senate Office Building. This tunnel houses the chilled water supply and return mains in addition to two 16-inch steam service pipes to serve the Library of Congress, the Annex to the Library of Congress, the Supreme Court Building, the Additional Senate Office Building (now under construction) and the First Street Wing of the Senate Office Building.

The above mentioned buildings, except the Additional Senate Office Building, now have their own refrigeration systems and the air handling cycles are all of the open washer type. The conversion of these equipments to closed coil operation suitable for use with a central chilled water system is now in progress so as to integrate these systems with the central refrigeration plant.

Design Considerations

An analysis of the ratio of present requirements to ultimate requirements (8,800 tons to 13,170 tons), of the available space, of the commercial equipment sizes, and of the practical loading considerations, dictated the choice of four 2200 ton machines to meet the present load requirements. The resulting problem was to find a 2200 ton machine with approximately the same space requirements as one of the existing 800 ton machines without imposing excessive static and dynamic loads on the existing pile supported foundations. The new machines, as required by law would be of the centrifugal type, but the choice of refrigerant which was not set by Congress would affect the size of the equipment. The three common commercially available refrigerants, Freon 11, 12 and 114 were compared, considering thermodynamic properties, size and speed of machine required, price of refrigerant, and power required per ton of refrigeration. After consideration of all factors Freon 12 was chosen as being the best suited to this application.

In Fig. 2 it can be seen that the chilled water circuit is arranged for series-parallel operation of the refrigeration machines. As indicated, the two series connected pairs (1 and 1a, 2 and 2a) are connected in parallel. The series operation for each pair was adopted after analysis of the operating characteristics of the machines indicated that a theoretical net horsepower saving of approximately 10% could be realized. A straight series circuit as employed in the existing plant could not be used because provisions had to be made for future ma-

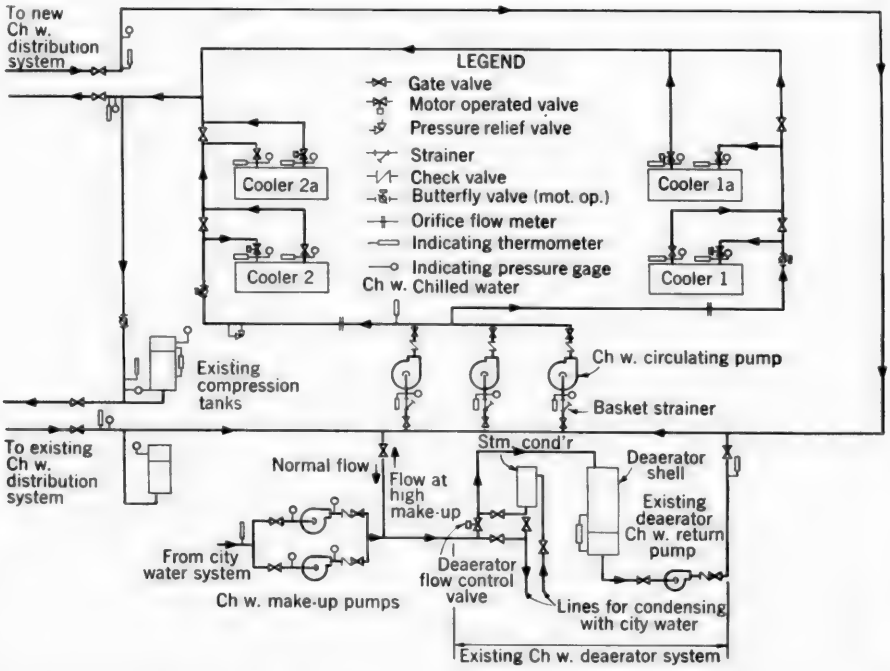

Fig. 2. Chilled water system flow diagram. Future machines not indicated.

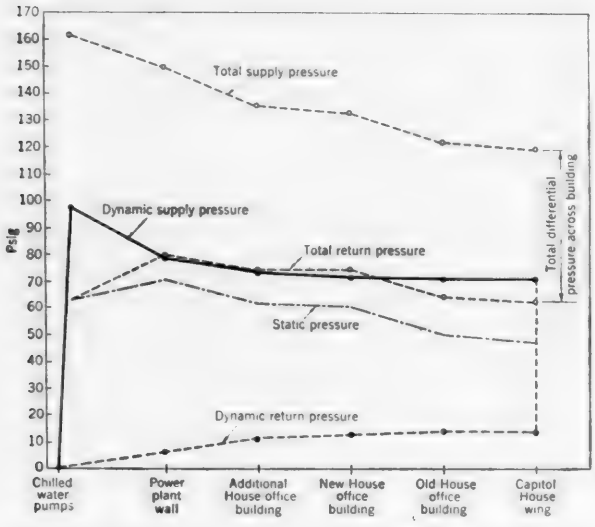

Fig. 3. Hydraulic gradient for original distribution system with new chilled water flow.

chines. The economy of operation develops from the basic consideration that refrigeration equipment, in general, requires more horsepower per ton as the operating temperature decreases. Therefore when two machines are connected in series, with the lead machine operating at the higher suction temperature and carrying more than half of the total load, a net saving in brake horsepower results. If the lead and follower machines are not required to be identical, the point of load division may be established so that smaller equipment could conceivably be selected for the second stage of cooling. The greater the temperature differential required, the greater the benefit which may be derived by series connecting groups of chillers. In this case it was decided that identical machines would be advantageous from the standpoint of maintenance and interchangeability of spare parts. Under this requirement 2500 horsepower motors were selected for each nominal 2200 ton compressor drive. The 2200 tons units were the largest possible utilizing 2500 horsepower motors. The next step would require 3000 hp motors. In addition, each speed increaser was required to be identical, thus each compressor operated at the same speed. Under these conditions maximum operating economy is obtained when the lead machine is fully loaded to the capacity of its driving motor, taking advantage of the lower bhp/ton at the higher water temperature range, the remainder of the required load being carried by the second machine of each pair.

Another important advantage of series arrangement occurs at partial loads. A fixed leaving water temperature can be maintained automatically without the valve manipulation otherwise necessary to disconnect chillers from the circuits. One machine of a pair may be inoperative as far as the refrigerant cycle is concerned but may still remain in the water circuit, all cooling being done by the other machine. In a straight parallel arrangement, any machine shut down must be valved off, as a mixture of water passing through the operative and inoperative machines will result in a leaving water temperature higher than 40 deg unless the operating machine cools to a temperature low enough for a mixture temperature of 40 deg to result. This arrangement would be uneconomical in both power and efficiency.

Hydraulics

To determine the required pumping heads for the new chilled water distributing system, extensive calculations were required. Advantage was taken of the opportunity to compare the results of theoretical determinations with actual gage readings taken at different points on the existing distribution system. The size of pipe, temperature of water, and magnitude of flow, in the existing distribution system closely paralleled conditions which were expected to prevail in the new distribution system. After determining the formula giving the most accurate results for the existing system we felt justified in utilizing this same formula for determining the pumping head for the new portions of the system. The method of calculation which proved to be the most accurate was the well known rational analysis, wherein

$$h_f = \frac{fLV^2}{D2g}$$

where units are in feet, feet per sec, and feet per sec^2 as applicable, and f was obtained from the Moody chart. The rational method of calculation gave results in which the greatest error was 5%, but the majority of points checked within 2%.

By a trial and error procedure, using the rational analysis for determining pressure drops, the hydraulic center of the system was established at the United States Capitol. By circulating the water from two directions, part through the existing piping system and part through the new piping system, and equalizing the pressure drops, the minimum pumping head was established. Refer to plot plan Fig. 1. A hydraulic gradient for the existing portion of the chilled water distribution system with the new flow conditions is presented in Fig. 3. By carefully determining the static pressure in the system at shutdown it was determined that a minimum air pressure of 60 psig must be maintained in the expansion tanks to keep the entire system filled with water during shutdown periods.

In recent years the plant has averaged 2500 operating hours per season producing an average of 2000 tons of refrigeration. The existing distribution system was designed to operate at constant flow, regardless of variations in building cooling requirements, by by-passing the excess water. This was accomplished by the operation of building controls which assured each building receiving a proportionate and constant flow of chilled water. This type of system, while basically simple in design, and appropriate for the volume of water in the original system does not lend itself to economy of operation in the expanded system. The chilled water circulating pumps for instance, operate at a constant horsepower regardless of refrigeration load. By varying the flow according to the building demand, it can be seen that substantial savings can be made in pump horsepower. The total brake pump horsepower for the existing system was 800. The ultimate requirement for 13,170 tons, or 26,340 gpm, coupled with the head requirements determined from the hydraulic analysis discussed previously, showed an ultimate pump requirement of 1900 brake horsepower. With a load of this magnitude consideration had to be given to possible horsepower economy which could be achieved by a variable flow system.

Rather than utilizing variable speed motor drives on the pumps it was decided to make use of the throttling controls presently on the majority of the building cooling coils. The throttling action of these valves provides automatic regulation of the pump's capacity by shifting the operation on the pump characteristic curve. By referring to the pump curves, Fig. 4, we see that considerable horsepower economy may be realized by automatically throttling back on the head-capacity curve for partial loads. Although the actual operating savings with a variable speed pump drive would be greater because of a more precise flow-horsepower relationship, the effect of the higher initial cost considering the variable speed motor, starter, and automatic flow controls precluded its choice over the constant speed pumping system. In effect, a variable flow system using constant speed pumps is a compromise between the maximum economy possible with a variable speed drive and the minimum economy of the constant flow system.

As previously established, the average load will be approximately 50% of the connected load, or 6600 tons for the future ultimate system. Transferring this to actual figures and with the use of the pump curve it is seen that while a constant flow system of 26,340 gpm would consume 1900 hp × 2500 hr or 4,750,000 hp-hr per season, a variable flow system which averaged 13,170 gpm for the same period would consume 1440 × 2500 or 3,600,000 hp-hr. These figures converted to terms of dollars, represent, at 1¢ per kw-hr, a saving of approximately $8,600 per year in operating costs. This is a substantial economy realized merely by devoting additional engineering time to the study of the system during the design period. It might be interesting to note at this time that the horsepower required to circulate the water through the system is of such magnitude that it actually adds 385 tons load to the system by the energy added while pumping.

In order to completely analyze the hydraulics of the pump operations described it was necessary to analyze also the system within each building. The building control systems were studied and modifications were recommended as required. As mentioned elsewhere in this article, each of the existing buildings is provided with a constant flow device for the building as a whole, but the individual coil controls are of the throttling type. To eliminate the need for replacement of large numbers of these valves, control valves were selected to be located at

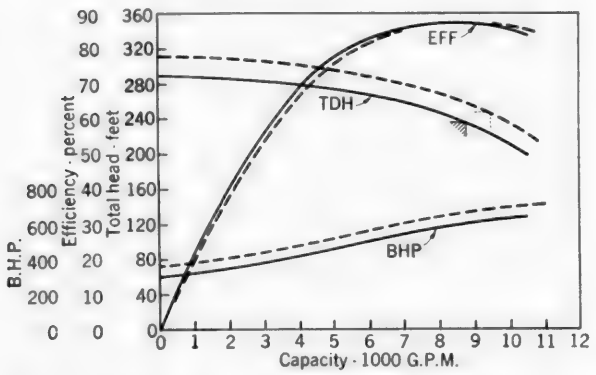

Fig. 4. Typical pump curves. Broken lines indicate future conditions.

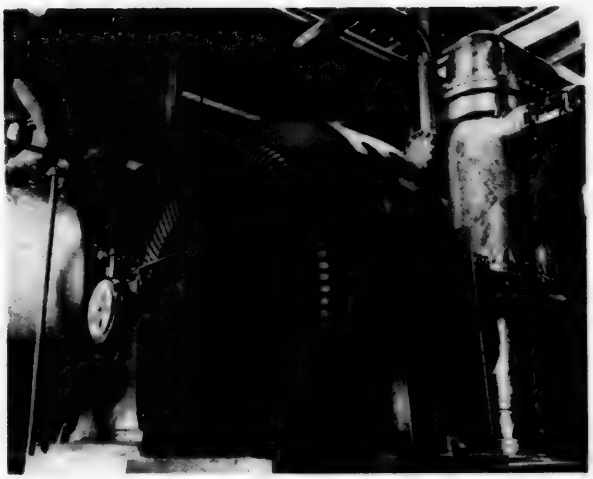

Fig. 5. Existing 1000 hp, 25 cycle synchronous motor.

the branch supply line entering the building. The function of the new valve is to limit the pressure entering the building to a figure approximating its original value with the old system. The use of the constant flow device, consisting of a flow meter controlled by-pass valve will be discontinued. Figures 5 and 6 show items of existing equipment.

Cooling Tower Selection

The present condenser water requirements are supplied by water pumped from the Anacostia River as mentioned earlier. In recent years the temperature of the river water at the pump suction has increased to over 90 deg on some days with consequent decrease in available plant capacity. The possibility of moving the pump suction was studied but temperature readings taken at various depths across the width of the river indicated a maximum 2 deg difference in temperature from bottom to top. With this in mind consideration had to be given to establishing another source of cooling water to meet the expanded plant requirements. The ultimate load requires a total condenser water circulation of 39,600 gpm. A cooling tower installation with the advantages of supplying cleaner water at lower temperature than could be obtained from the river, plus the fact that the existing river pumping station required costly modernization, swayed the choice heavily in favor of the tower. The cleaner water anticipated, meant a lower fouling factor could be utilized in condenser design and at the same time would reduce maintenance and operating costs. The lower water temperature available meant a reduction in the size and cost of the condenser, with a lower power input to the compressor. The tower selected was an induced draft double-cased redwood type with extended interior columns resting on the basin floor. The outer wall is corrugated cement asbestos, mainly for appearance. The tower is provided with a complete automatic sprinkler system for protection during the shutdown periods. As consideration was being given to possible winter operation, it was decided to partition the tower basin so that individual cells and portions of the basin could be utilized. Slide gates were provided in the basin partitions for operation of basin units as required. This partitioning provided an excellent method of draining with minimum danger of freezing in case of severe

Fig. 6. North half of equipment room showing existing equipment to be removed in second stage of construction.

temperature drop often encountered during the winter season.

Controls

Early in the project it was decided that although chilled water temperature control was the only control to be fully automatic, a complete metering system would be required so as to enable the operating personnel to log all necessary data from a central point, and control all valves, watch for alarm signals, and start and stop motors, as required from this control point. The 2500 hp motors can be started only from the local panels at each compressor. All alarms referring to refrigeration units are duplicated at local boards adjacent to the machines. The automatic temperature control is designed to provide 40 deg water leaving the second machine of each series-connected pair. The controller divides the load on each machine by setting the gas inlet vane controls. The proportion of the load carried by each machine can be adjusted by a biasing controller, located on the central control panel. In this manner the lowest net horsepower of the combination may be established at any particular loading and after sufficient operating data has been collected, a procedure can be worked out to obtain optimum operating conditions at any load.

Vibration

Despite assurances from the several refrigeration equipment manufacturers that vibration was not a consideration in machines of this type, it was decided, because of the pile pattern and existing slab design, to investigate the vibration problem fully before proceeding. The pile pattern supporting the existing 15-inch reinforced slab was peculiar in the respect that there is a 15-foot brick arch sewer passing diagonally beneath the refrigeration apparatus room. No additional piles could be driven to support an increased load or to alter the natural frequency of the structure.

Investigation of the machine loads mounted solidly on the reinforced concrete floor, which acts as a pile cap, indicated that the natural vibration frequencies for the supporting piles were within close range of the disturbing frequencies of the motor. In order to make use of the existing pile foundation system without alteration and to prevent resonance, consideration had to be given to the use of spring type isolators. Proper isolator deflections had to be determined, and distributing motor frequencies had to be converted to vibration frequencies that did not approach resonance with the natural frequency of the piles during normal operation periods. Since the natural frequencies of the piles could not be adjusted to a range above the disturbing frequencies of the motor at 900 rpm, or the compressor at 4870 rpm, the natural vibrations frequency for the isolators had to be selected for a range within the starting period of the machines. A maximum of 540 cpm, or 40% below the 900 rpm of the motor, for the isolator was considered as a safe limit, allowing for design descrepancies or manufacturing tolerances. Experience from similar types of coupled and rotating machines creating impact forces on a foundation established certain weight factors above the isolators which had to be achieved.

Mounting Base

The differential deflection amplitudes caused by impact forces of the isolator had to be kept to a minimum to avoid undue bending stresses at the service pipes leading to and from the refrigeration unit. It was decided to mount the entire refrigeration unit on a rigid steel and concrete filled frame providing for accurate alignment and to prevent relative movement of any of the major components of the unit. This entire assembly was mounted on the vibration isolators. In Fig. 7, which shows the steel

Fig. 7. Partially completed machine base showing spring vibration isolators on outriggers from main steel base.

frame before the setting of the equipment, it can be noted that the chiller and condenser are to be mounted on the outriggers which project from the main steel base. A total weight of the concrete filled steel frame, without the outriggers, of not less than the sum of the superimposed loads of the motor, speed increaser (Fig. 8), compressor, and accessories, was found to be suitable to obtain sturdy isolator units, high deflection amplitude absorption, and a loading condition which was not in excess of the pile carrying capacities.

After selecting the proper isolator and base it was established that (1) the disturbing frequencies of the motor and compressor would be in resonance with the natural frequencies of the isolator twice for short intervals during the starting periods of the machines; (2) the converted disturbing frequencies at the bottom of the isolators would not be in resonance with the building structure; (3) horizontal vibration disturbance could not occur.

The chilled condenser water piping was isolated from the spring mounted refrigeration unit by the use of flexible connectors. The 20-inch chilled water connection presented a unique problem in that the flange-to-flange distance for the connection was limited to 23 inches while at the same time requiring a design deflection of ¾ inch in the lateral direction. Design pressure was 190 psig.

The manufacturer of the connectors met the problem by providing a two ply bellows of stainless steel with no equalizing rings. Limit rods to absorb the internal pressure thrust were isolated from the connector proper by non-metallic washers and bushings. See Fig. 9.

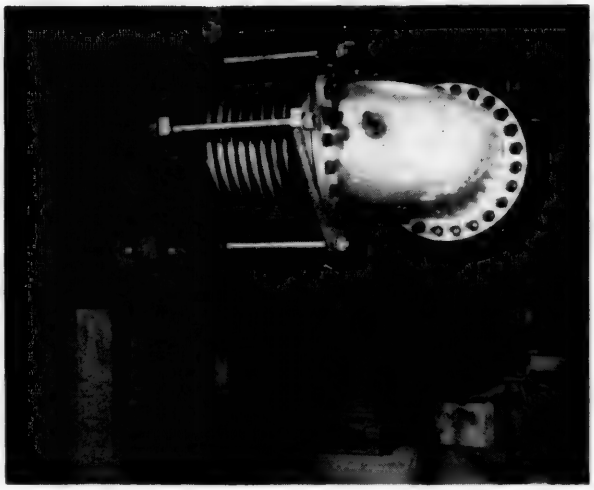

Fig. 9. A 20-inch flexible connector and spring isolator.

Electrical

The existing electrical installation consisted of 6,600 volt, 25 cycle service originally generated at the Capitol Power Plant but more recently provided by the Potomac Electric Power Company. In line with the Public Law 413, all electrical installations on Capitol Hill are being converted to 60-cycle a-c current and therefore the new refrigeration facilities were required to conform. The power company has provided three 13,200 volt feeders, direct from their generating facilities. Any two of the feeders will carry the full refrigeration and adjacent boiler plant load, allowing for outage of the third feeder. The substation design consists of a future total of four 13,200/4160 volt, 5,000/6250 KVA forced air cooled transformers and associated switchgear. One transformer provides spare capacity.

All large motors were selected to operate at 4000 volts. These included the 2500 hp compressor motors, the 700 hp chilled water pump motors, and the 300 hp condenser water pump motors. Smaller motors operate at 208 volts.

The 2500 hp motors were selected to be synchronous type, unity power factor with across the line starting.

Construction Schedule

As was pointed out earlier, one of the fixed conditions of the project was the maintenance of existing air conditioning service during the operating season between April 15 and November 15. This meant that no construction work affecting the operation of the existing equipment could be performed between those dates, and by April 15 there would have to be enough capacity on the line to meet any foreseeable load.

In considering the total amount of work to be done and the limited time (November 15th to April 15th) available, it was considered doubtful that the entire modernization program could be completed in one season. The work therefore was planned in two stages to carry over two years, in order to meet the above requirements. By leaving four of the existing machines and all the pumping facilities intact for the first summer, sufficient undisturbed capacity was retained to carry the load through the month of May. The other two machines were removed and replaced in stage one with two of the new centrifugals, the combined capacity of which was only slightly less than the capacity of the original six reciprocating machines. Since no new load was to be connected to the central plant until the expansion was complete, the two new machines, after being tested and placed on the line, could carry the entire demand for the remainder of the first summer. This plan provided added protection in the event one or both of the new machines proved defective, necessitating extensive repairs or adjustment resulting in lengthy shut-down periods. The new cooling tower piping was connected to the existing river water piping and so valved as to enable the source of condenser water supply to be chosen as desired until the cooling tower was tested and accepted. At this point the river piping will be permanently disconnected from the plant. The larger part of outside work was scheduled for stage one since this would least affect present operation. The electrical installation was planned to be complete to the extent of permiting operation of the new equipment required to operate in stage one. This method of staging the construction has worked out well because of the close cooperation of the Contractor, the Consulting Engineer and the Office of the Architect of the Capitol.

Fig. 8. New 3000 hp speed increaser and 2200 ton compressor.

Credits

Engineering, design, preparation of working drawings and specifications, and supervision of construction is by Guy B. Panero, Consulting Engineer.

The Contractor for the Project is Standard Engineering Company of Washington, D. C. Refrigeration machines were built and erected by the York Corporation.

Power Requirement for Streamline Fluid Flow

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The kinetic energy of streamline flow differs from values obtained through simpler equations which apply to turbulent flow. Engineers working in low Reynolds numbers may avoid underpowering equipment such as fans and pumps by proper attention to factors analyzed in this article.

WHENEVER motion is imparted to an initially stationary fluid—whether for exhausting room air through a duct or for pumping water from a tank—power must be provided to supply work which goes into storage in the fluid as kinetic energy or becomes associated with the fluid as flow work. As flow continues and the pressure drops, conversion of flow work to friction occurs, but—for an incompressible fluid in a duct or pipe of uniform cross-section—the kinetic energy in storage remains constant.

In usual engineering practice—particularly in the fields of heating, ventilating and air conditioning—fluid velocities through ducts and conduits are ordinarily so high that flow is in the turbulent region. For this case the velocity of each small volume of fluid is practically equal to the mean flow velocity and the amount of kinetic energy associated with the fluid is calculated by the usual equation

$$\text{Kinetic energy} = wv_2/2g \text{ ft-lb per sec} \qquad (1)$$

where w is the flow rate in pounds per second, v is the mean fluid velocity in feet per second, and g is the acceleration due to gravity (32.2 feet per second^2). For turbulent flow the velocity, v, is obtained from the continuity equation

$$v = V'/A \quad \text{ft per sec} \qquad (2)$$

where V' is the volume of flow in cubic feet per second and A is the cross-section area in square feet.

Because of the fact that equation (1) is valid for the great majority of engineering applications, there is hazard that the engineer may lose sight of the fact that a requirement for applicability of this equation is the existence within the fluid of fully developed turbulence. When fluid velocity decreases or when viscosity increases, the conditions of flow may be altered so that a transition will occur to streamline flow. The transition occurs when the dimensionless flow parameter—Reynolds' number—has a value of approximately 2000. Under these circumstances equation (1) is no longer valid and—if erroneously used—may lead to underpowering of the requisite fan, blower, or pump.

The intent of this article is to develop the accurate kinetic energy equation for streamline, or viscous, flow, and to point out that the error through misuse of equation (1) would be of the order of 100%. Thus the distinction between streamline and turbulent flow is one of great practical significance and the engineer should always bear in mind the large non-conservative error that will occur if equation (1) is used for systems involving viscous flow.

Characteristics of a Real Fluid

The ideal hydrodynamic fluid which is used in developing the elegant derivations of classical hydrodynamics fails to correspond to a real fluid in two vital respects. First, by virtue of the viscosity possessed by all real fluids, tangential stresses are set up which lead to major deviations of the actual from the ideal fluid, and, secondly, with all real fluids there is a stationary layer adjacent to any boundary or to any solid body immersed in the fluid. This stationary layer is always present, and, though not of great thickness, it is nonetheless responsible for very significant departures of real fluid behavior from that which would be expected from analysis of an ideal fluid. This is particularly true because of the steep velocity gradient which must exist in the region near the wall. The impossibility of slip is then an outstanding and very vital characteristic of all real fluids. Because of it the entire subject of fluid flow becomes immeasurably more complicated.

When any real fluid is in motion, the resultant force exerted on a small element of boundary will be made up of a pressure component normal to the boundary and a tangential stress component parallel to the boundary; additional mass or volume forces, as the forces of gravity, also act on the body, but for small elements of volume, such forces can be neglected, since they are of a higher order than the boundary forces. For such a fluid the forces acting at any point within the volume will not be the same in all directions and likewise the force at any point on any plane within the fluid will not necessarily be normal to the plane, but will be the resultant of the pressure (which is always and by definition normal to *any* plane) and a shearing stress. Assuming that mass forces can be neglected, all deviations of resultant stress from normal pressure can be attributed to viscosity.

Mean Velocity of Fluid in a Pipe, Duct, or Conduit

Accurate knowledge of the mean velocity, v, of various small elements throughout a given volume of fluid is of the greatest practical importance, since only from such data is it possible to determine velocity gradients and hence tangential stresses. Likewise, precise information on velocity distribution is prerequisite to a determination of the kinetic energy of the fluid mass. For any small element of mass, moving uniformly with velocity, v, the kinetic energy is given by equation (1)

$$KE = (1/2)v^2/g \quad \text{ft-lb per lb} \tag{3}$$

If flow were to occur through a pipe of circular cross-section with uniform velocity across the area normal to flow, the kinetic energy would likewise be given by equation (3) with the velocity defined as the ratio of rate of flow, V' cu ft per sec, to cross-section area, A,

$$v = V'/A \quad \text{ft per sec} \tag{4}$$

Equation (4) is true only when the velocity is uniform, though in other cases it can be used to determine a mean velocity, $\boldsymbol{v}$, across the section. Here, however, a major difficulty occurs since the mean velocity squared can differ very considerably from the mean of the squared point velocities. Hence,

$$KE = \sum_{A} (1/2)\, v^2/g \neq (1/2)\, \boldsymbol{v}^2/g \quad \text{ft-lb per lb} \tag{5}$$

Two possible methods of correction are available. The first and most logical would be to accurately determine a mean value of v^2 and use this value in equation (3). The second procedure and the one most commonly used in practice is to evaluate the mean v^2 in terms of the mean velocity, $\boldsymbol{v}$, giving

$$v^2 = K\boldsymbol{v}^2 \quad (\text{ft per sec})^2 \tag{6}$$

where

$$\boldsymbol{v} = V'/A \quad \text{ft per sec} \tag{7}$$

The value of the dimensionless coefficient, K, will obviously depend on the velocity distribution over the cross-section.

The kinetic energy expressed in foot-pounds per unit volume can be readily obtained from equations (3) and (6) by dividing by the specific volume, $\boldsymbol{V}$,

$$KE = (1/2g)\ (K/\boldsymbol{V})\boldsymbol{v}^2 = \frac{K\boldsymbol{v}^2}{2\boldsymbol{V}g} \text{ ft-lb per cu ft} \tag{8}$$

Then noting that the *mass* density, ρ, is equal to $1/\boldsymbol{V}g$ and making this substitution in equation (8),

$$KE = (1/2)K\rho\boldsymbol{v}^2 \quad \text{ft-lb per cu ft} \tag{9}$$

which is in units of ft-lb per cubic foot, but has the dimensions of pounds per square foot and hence is dimensionally equivalent to pressure. In another sense also this term is equivalent to a pressure since it indicates that the unit volume of fluid has stored within it an amount of kinetic energy sufficient to raise itself—during deceleration—to a vertical height equal to $(1/2g)K\boldsymbol{v}^2$ feet. Thus $1/2(K\rho\boldsymbol{v}^2)$ can be defined as a *velocity pressure*, in pounds per square foot absolute while $(1/2g)K\boldsymbol{v}^2$ is a *velocity head*, in feet of fluid.

Example 1: Flow through a circular pipe is assumed to occur under conditions such that the velocity decreases from a maximum in a small diameter circular cross-section area near the center to a minimum in a ring of equal cross-section area near the outside. The pipe cross-section is divided into four annular rings of equal area enclosing a fifth central circular cross-section of the same area. Assume that the velocity remains practically constant in each of the stated areas (thus discontinuities would have to occur between rings) and investigate the error that would result if the square of the average velocity were used in place of the average of velocities squared. Velocities in the five areas, from center out, are 10, 8, 6, 4, and 2 ft per sec, respectively.

Solution: The average velocity is

$$\begin{aligned}\boldsymbol{v} &= (v_1 + v_2 + v_3 + v_4 + v_5)/5 \\ &= (10 + 8 + 6 + 4 + 2)/5 = 30/5 \\ &= 6 \text{ ft per sec}\end{aligned}$$

so

$$\boldsymbol{v}^2 = 6^2 = 36 \quad (\text{ft per sec})^2$$

But the average of velocities squared is

$$\sum_{n} v_n^2/n = (10^2 + 8^2 + 6^2 + 4^2 + 2^2)/5 = 220/5$$

$$= 44 \quad (\text{ft per sec})^2$$

The error resulting from use of $\boldsymbol{v}^2$ would therefore be

$$[(44 - 36)/44]100 \text{ or } 18.2\%$$

Velocity Distribution and Evaluation of Kinetic Energy

As discussed above the kinetic energy term cannot be accurately evaluated until data are available to permit establishing a relationship from which this term can be related explicitly to the mean velocity of flow. As written in equation (8) the kinetic energy term included a coefficient K which is yet to be determined; this coefficient will vary with the type of flow and means must be found for relating it to the mean velocity.

As a first step in the analysis of any given flow the velocity distribution must be determined. Once this is known a next step is to carry out the requisite integration over a cross-section of the stream of flow in order to determine the total rate at which kinetic energy is being carried through the cross-section. The last step in the analysis, and the easiest, is to relate the known kinetic energy to the known mean velocity, thereby obtaining the numerical value, for the specific system, of the coefficient, K.

Laminar Flow Velocity Distribution

Below a certain critical value of Reynolds' number (approximately 2000) all fluids flow with a streamline pattern which is developed from the fact that there is no radial component of velocity. Considering the case of laminar flow in a pipe, the velocity in the direction of motion will be a constant over any cylindrical shell centered on the pipe center. Since there can be no slip at the pipe wall, it follows that the velocity must increase as the pipe axis is approached, hence the gradient—in the radial direction—is equal to dv/dr (where v is the axial velocity of fluid that is a distance r out radially from the axis). Consider now a cylinder of fluid of unit length centered on the pipe axis and of radius, r. For steady state conditions of laminar flow this cylinder of fluid must be in equilibrium, hence the viscous forces acting on its curved surface must be exactly balanced by the force due to the pressure difference acting over its two ends.

The viscous stress, $\mu\ (-\ dv/dr)$ acts over an area, 2π r, hence force due to this cause is $-\ 2\pi\ r\mu\ (dv/dr)$. This must be exactly balanced by the force due to pressure

difference which is $(\triangle P)\pi\ r^2$. Hence, it follows that

$$-2\pi\ r\mu(dv/dr) = \pi r^2\ (\triangle P)$$

or

$$(dv/dr) = -\ r\triangle P/2\pi \qquad (10)$$

where $\triangle P$ is the pressure drop in the direction of flow per unit length of cylinder, the *pressure gradient*. Then

$$v = -\ (\triangle P/2\pi)rdr \qquad (11)$$

and the limits of the integral can be established from the condition of no slip which requires that v equal zero when r is equal to the pipe radius a. Then

$$\begin{aligned} v &= +\ (\triangle P\ 2\pi)\textstyle\int_{r=r}^{r=a} rdr \\ &= +\ (\triangle P\ 4\mu)\ (a^2 - r^2) \end{aligned} \qquad (12)$$

Equation (12) is of the form of a parabola, hence indicates that parabolic distribution must exist across the pipe when flow is laminar. The velocity at any radius varies directly with the pressure gradient.

Laminar Flow: Mean Velocity

The mean velocity can be calculated from equation 12 by considering a thin-walled cylinder of fluid of radius r and wall thickness dr, centered coaxially with the pipe. Then the mean velocity will be

$$v = [\textstyle\int_{r=0}^{r=a} v(2\pi r)dr]/\pi a^2$$

Substituting from equation 12

$$\begin{aligned} \mathbf{v} &= \textstyle\int_{r=0}^{r=a} 2\pi\ (\triangle P)(1/4\mu\pi a^2)(a^2 - r^2)rdr \\ &= (\triangle P/2\mu a^2)\ \textstyle\int_0^a (a^2r - r^3)dr \\ &= (\triangle P/2\mu a^2)\ [(a^2r^2/2) - (r^4/4)] \\ &= (\triangle P/2\mu a^2)\ [(a^4/2) - (a^4/4)] \\ &= (\triangle P)\ (a^4)/(8\mu a^2) \\ &= (\triangle P)\ (a^2)/(8\mu) \end{aligned} \qquad (13)$$

From this it follows that the pressure drop per unit length for a laminar flow system is

$$(\triangle P) = 8\mu\boldsymbol{v}/a^2 \qquad (14)$$

The maximum velocity occurs at pipe center and, from equation 12, is

$$v_{max.} = (\triangle Pa^2/4\mu) \qquad (15)$$

hence from equations 13 and 15 it follows that the mean flow velocity for a laminar stream is equal to one-half of the maximum velocity.

Laminar Flow: Kinetic Energy

For the kinetic energy term, however, what is needed is the average value of v^2 rather than the average of v. Thus the kinetic energy over a cross-section can be obtained by integration of the kinetic energies of the infinite number of infinitesimal shells of co-axial cylinders in the wall for each of which the velocity is constant. Thus for any such shell with radius r and thickness dr, the mass of fluid passing a given cross-section in unit time is equal to $w(2\pi rdrv)$ and the kinetic energy of this volume is in ft-lb per sec

$$KE_{cyl.} = (v^2/2g)\ (2\pi rdrvw) = w(\pi/g)v^3rdr \qquad (16)$$

Then substituting for v in terms of r from equation (12)

$$KE_{cyl.} = [w\pi(\triangle P)^3/(64g\mu^3)](a^2 - r^2)^3rdr$$

and the kinetic energy of the total volume of fluid passing a cross-section of the pipe is

$$KE = [w\pi(\triangle P)^3/(64g\mu^3)]\textstyle\int_{r=0}^{r=a} (a^2 - r^2)^3rdr \qquad (17)$$

Then

$$\begin{aligned} \textstyle\int_{r=0}^{r=a} (a^2 - r^2)^3rdr = \textstyle\int_{r=0}^{r=a} (a^6 &- 2a^4r^2 + a^2r^4 \\ &- a^4r^2 + 2a^2r^4 - r^6)rdr \\ a^8/2 - 3a^8/4 &+ 3a^8/6 - a^8/8 = a^8/8 \end{aligned}$$

and

$$\begin{aligned} KE &= [w\pi(\triangle P)^3a^8]/[64g(\mu)^38] \\ &= [w\pi(\triangle P)^3a^8]/[(\mu)^3g512] \\ &= [w\pi\ 2g]\ [(\triangle P)^3a^8]/[256(\mu)^3] \text{ ft-lb per sec} \end{aligned} \qquad (18)$$

But this is for a fluid mass equal to the pipe cross-sectional area multiplied by the density and by the mass velocity or

$$\text{Mass} = \pi\ a^3w\boldsymbol{v} \quad \text{lb}$$

and substituting for $\boldsymbol{v}$ from equation (13)

$$\text{Mass} = \pi a^2w[(\triangle P)a^2/8\mu] = \pi a^4w(\triangle P)/8\mu \text{ lb} \qquad (19)$$

Hence the kinetic energy per unit mass passing through a given cross-section of the pipe is

$$\begin{aligned} KE &= [w\pi(\triangle P)^3a^8/2g256\mu^3]/[\pi a^4w(\triangle P)/8\mu] \\ &= [(\triangle P)^2a^4/64g\mu^2] \quad \text{ft-lb per lb} \end{aligned} \qquad (20)$$

But it is desired to express the kinetic energy by the equation $KE = (1/2g)K\boldsymbol{v}^2$ where $\boldsymbol{v}$ is the mean velocity hence writing an equality between the two expressions for KE, substituting for $\boldsymbol{v}$ from equation (13) and solving for K

$$\begin{aligned} KE &= (1/2g)K\boldsymbol{v}^2 = (1/2g)\ K\ [(\triangle P)^2a^4\ 64\mu^2] \\ &= (\triangle P)^2a^4/64g\mu^2 \end{aligned} \qquad (21)$$

giving $K = 2$.

Thus in terms of the mean velocity the kinetic energy of a stream in laminar flow is $\boldsymbol{v}^2/g$, which is exactly twice as great as the kinetic energy which would exist if the velocity were constant over the entire cross-section. Since the parabolic distribution results from the no-slip condition, it appears that this 100% increase in the kinetic energy of flow results from the fact that all fluids are viscous. Note that the value of the viscosity has no quantitative effect on the amount of increase; all fluids whether highly viscous or of infinitesimal viscosity show exactly the same kinetic energy increase when moving under conditions of laminar flow in a circular conduit. The quantity of viscosity does indirectly influence the kinetic energy, however, in that it plays a part in determining the critical Reynolds' number and hence, for a given fluid, the critical velocity at which a transition will occur from laminar to turbulent flow. The greater the viscosity the greater will be the velocity range over which laminar flow—and hence a high kinetic energy loss—will exist.

The value of K determined for laminar flow is of further significance in that it is independent of the Reynolds' number or of any other condition of flow subject only to the requirement that a fully-developed parabolic

velocity distribution exists across the pipe. This is in marked contrast to the situation in the transient region where the value of K increases with the degree of turbulence and therefore with the Reynolds' number.

The doubled kinetic energy requirement for laminar flow is of great practical importance in pumping problems associated with heavy oils, syrups and other viscous materials. This is particularly true in cases where flow is by gravity and the flow rate, based on a given head, requires precise evaluation of the energy possessed by or dissipated by the fluid in transit. For the greater number of practical flow problems, however, the 100% increase in kinetic energy which is associated with laminar flow is not a matter of concern as the velocities used for most fluids are sufficiently high to place the flow in the turbulent rather than laminar range. This is especially true in applications where flow is in a continuous closed circuit (in contrast to cases where the fluid is pumped from a stationary condition), since the change of kinetic energy between cross-sections of a pipe is likely to be very small in comparison with changes in other energy quantities except in those cases—as turbine nozzles and jets—where the velocity is so high as to place the flow unquestionably in the turbulent category.

Transition from Laminar to Turbulent Flow

The most significant physical distinction between laminar and turbulent flow is that with the former every element of fluid (except the stationary molecular layer adjacent to a solid boundary) has no component of velocity in any direction other than that of the main stream. With turbulence, however, vortices or eddies exist throughout the fluid and each fluid element possesses, in addition to a steady velocity in the direction of flow, additional fluctuating components of velocity which serve to greatly increase the actual length of path of the fluid element as it flows between any two cross-sections of the pipe.

The difficulty in establishing a procedure for analysis of turbulent flow is very great because velocity components exist in all directions and a three-dimensional framework of reference must therefore be used. Of even greater difficulty is the analysis of fluid motion during the transition stages where time must be considered as a fourth independent variable. Flow in the transition region differs from fully developed turbulence not so much with respect to the motion of the fluid elements as with respect to the time interval during which that motion—or an average macroscopically equivalent to it—exists. During transition the eddies which constitute turbulence first occur for only a brief time interval, then at more frequent time intervals until, when turbulence is fully developed, the variation of macroscopic motion as a function of time and of lineal position is entirely negligible. During transition, however, the fluctuations occur periodically and the fluid actually undergoes a series of local transitions to and from fully developed local turbulence. The higher the Reynolds' number the more rapid the fluctuations become and the shorter is the lineal length of pipe required to reach the macroscopically steady state which is identified as fully-developed turbulence.

What might be thought of as a reverse transition—from turbulence to laminar flow—occurs following the entry of fluid into a pipe under conditions of moderate fluid disturbance. If the Reynolds' number lies between 280 and 1600, the fluid entering the pipe with sharp edged entry from a region of great fluid disturbance will produce a vortex sheet starting from the sharp edge and developing in wave like form with increasing amplitude until eventually the amplitude becomes so great that the sheet loses all stability, rolls up on itself, breaks into sections and discards individual and independent vortices which pass off in the fluid and, at some distance downstream, weaken and lose their identity. Irrespective of the magnitude of the initial fluid disturbance, flow conditions for Reynolds' number in this range from 280 to 1600 eventually smooth down to a condition of steady laminar flow. The distance required for the initially disturbed condition to disappear is a function of both the pipe radius and the Reynolds' number; sixty diameters may be taken as an approximation to the maximum transition length.

For Reynolds' number less than 280 the vortex sheet noted above never has an opportunity to develop and irrespective of the degree of initial disturbance flow in the pipe is laminar all the way from the point of entry.

For Reynolds' number slightly greater than 1600 another critical condition is reached and the flow once more enters a different stage. The entry vortex sheet which was previously noted now becomes a single stationary cylindrical vortex, usually of increasing thickness, which remains in place for about 2/3 of the total entry length after which it gradually constricts and eventually sheds a discrete eddy which moves downstream without loss of intensity. The stationary cylindrical eddy then goes through the same cycle, shedding subsequent discrete vortices at regular intervals. Once the flow has reached this stage there will no longer be sufficient damping effect to establish laminar flow and fully develop turbulence will exist throughout the entire downstream region.

If the fluid prior to entry is not subject to some disturbance, the critical value of Reynolds' number will increase greatly. For most practical purposes a critical value of 2000 is suggested as an adequate criterion for determining whether or not turbulence will develop when entry occurs from a region in which moderate disturbance exists. As entry conditions become more smooth, the critical Reynolds' number increases; when particularly smooth conditions exist, laminar flow has been maintained up to a Reynolds' number of three million.

Fortunately most practical flow problems occur either in the laminar region or at Reynolds' numbers sufficiently high so that the transition region can be ignored. In cases where transition is known to exist the kinetic energy of the fluid stream can be approximated by assigning K in equation (8) a value of 1.5.

Turbulent Flow

The mathematical theory of turbulent motion in a pipe is based on the concept of a steady mean flow with velocity v where v is a function of radial distance out from the pipe axis; on this mean velocity there is superimposed a turbulent velocity having the instantaneous components of u', v', w', the mean values of which are necessarily zero. For mathematical convenience the terms u'', v'', and w'' are also used, each term signifying the root-mean-square value of the corresponding turbulent components.

The root-mean-square turbulent velocities, u'', v'', and

w'' have a very special significance, since experiment indicates that for a section of fluid in which fully develop turbulence exists the values of these terms are practically the same in all directions. For flow in a pipe this condition holds very closely for fluid elements near the axis and sufficiently downstream from the inlet so the motion of the element in question no longer retains any characteristics of its original motion. When this condition of equality between root-mean-square velocities is realized, the flow system is said to possess isothropic turbulence and the possibility of achieving mathematical expression of its motion is greatly disturbed.

As the degree of turbulence increases it will be found that K of equation (8) will tend to decrease from the laminar flow value of 2 to a value of unity. The latter value corresponds to a flat velocity distribution over the cross-section, hence to shrinking of the region in which velocity reduction takes place to a very narrow band in close proximity with the pipe wall. For most practical purposes the velocity, for turbulent flow, can be considered uniform over the entire cross-section (realizing, however, that the existence of slip actually requires zero velocity at the pipe wall and a correspondingly high velocity gradient adjacent to the wall).

Air Conditioning and Office Worker Efficiency

A task group of the Federal Construction Council reports that several governmental agencies have made extensive search for information from both industry and government on the effects of air conditioning on personnel, particularly with respect to increased work output. Surprisingly little useful information was found, the task group reports in Air Conditioning in Federal Buildings, Technical Reprint No. 2 of the Building Research Institute. Some of the information the group did find follows:

A single, informal investigation was made by a small Federal agency in the summer of 1946. Two temporary typists were employed to type triangulation data. They worked for two weeks in a non-air conditioned building in Washington. The girls were then transferred to air conditioned offices in Alexandria where they did the same work on the same typewriters. A comparison of typing output showed a 24.1% increase, which was attributed to working conditions, primarily air conditioning.

The task group points out that some of the reported increase in output should be credited to becoming familiar with the assignment. Other factors, such as change of location, lighting, type of office, or emotional responses also may have had a bearing on the work, and hence air conditioning should not be considered as the primary determinant in the test.

Another experiment was made in a non-air conditioned government office during a hot spell of summer weather. This was posed against autumn temperatures similar to those induced by summer air conditioning, with the following results:

For a 10-day spell in August-September with an average maximum temperature of 96.6 deg, average production was 212.9 units per man-hour. For a 10-day period in October when the average maximum temperature registered 70.3 deg, average production was 243.7 units per man-hour. This represented a 14.5% increase in output.

This comparison was not intended to simulate a controlled test of air conditioning. It was made to provide a comparison which may afford useful supplementary information until such a time as a controlled test is run. Shortcomings in the comparison are noted as follows: (1) Most of the filing work was done during the cooler hours of the morning; (2) the comparison was made for an unusually hot period rather than at an average summer temperature, and (3) the test was not observed; there is no assurance, for example, that the same employees did exactly the same work under identical office conditions.

An article by Eugene Whitmore for the July, 1949, issue of *American Business* relates the experience of C. F. Braun & Company, oil refinery and chemical plant manufacturers, after a move into a new building. It reported that a 35% increase in the production efficiency of 575 white collar workers in private offices was attributable to changes including air conditioning, high level lighting, improved space arrangement and equipment. Private offices for each individual, including draftsmen, cost the company approximately $3500 an office. This was charged off at about $25 a month as compared with $12 a month for the former low partitioned offices.

At an average salary of $360 a month for the men in these private offices, the article quotes an estimated saving of $90 a month per man. This is based on time saved because of more efficient offices, privacy, and better equipment. The Braun Company also was quoted as regarding this as a good return on the additional $1300 invested in each office. The task group observed that the 35% over-all increase in production, of which 25% was observed as time saved, followed a move to completely new quarters. The emotional acceptance of the new quarters alone, it is believed, could have produced some increase in production. The task group concedes, however, that a part of this work increase might well be attributable to air conditioning.

Paul G. Heidman, superintendent of buildings, for the Detroit Edison Company, cites a notable increase in production of 51.4% in work output when the company's drafting and surveying bureau was removed from an old non-air conditioned building into a new air-conditioned structure. The report, published in 1939, stated that 8,988 work units required 5,008 man-hours during the summer of 1937; during the summer of 1938, under air conditioning, 10,474 work units required only 3,872 man-hours.

The task group observed that the increase in output was unusually high in this move from one building to another. Where an increase is so great, the group feels that several factors have contributed to produce it, some of which could be purely psychological.

Centrifugal Pump Application

Part 5. Rating Curves and Specific Speed

By IGOR J. KARASSIK and ROY CARTER

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This is the concluding installment of a series which has reviewed the basic characteristics of centrifugal pumps as a guide in their selection and application. This month, the authors describe the effects of pump shape and speed on rating curves, suction lift, and net positive suction.

A rating curve for a centrifugal pump of specific design shows in a condensed form the possible range of applications of that pump, either for a range of impeller diameters or for a range in speed. A few lines of pumps, notably small motor driven stock units, are made with several different impeller diameters, of the same or of different patterns, which load up various sizes of motors. A rating curve for this type of pump is shown in Fig. 21. With such a line of pumps, a pump with a 25 hp motor and an impeller which would approximate the results shown on curve (2) would be furnished if the desired head condition fell anywhere within the zone between the H-Q curves (2) and (3) in Fig. 21. Thus, for some customer's requirements, such as 250 gpm 200 feet total head, the pump supplied would produce more capacity or head than required. When installed, this unit would either give excess capacity or excess pressure, depending upon the system, unless the discharge was throttled to increase the friction head artificially.

Some small centrifugal pumps for belt drives are manufactured in lots for stock sale, and the most efficient operating speed for each installation is obtained by selecting a proper pulley ratio to give the head and capacity condition desired. A curve showing the head, capacity, and brake horsepower for such a pump at a number of speeds, could be utilized for determining the speed necessary and the power involved. These rating curves are now rarely used. Instead, a table is generally more convenient and permits showing a number of pump sizes on the same sheet.

For pumps which are built-to-order with an impeller pattern and diameter individually selected for the desired

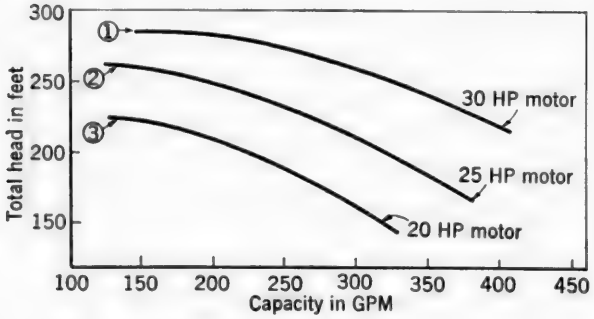

Fig. 21. Rating curve for a 2½-inch motor-mounted pump.

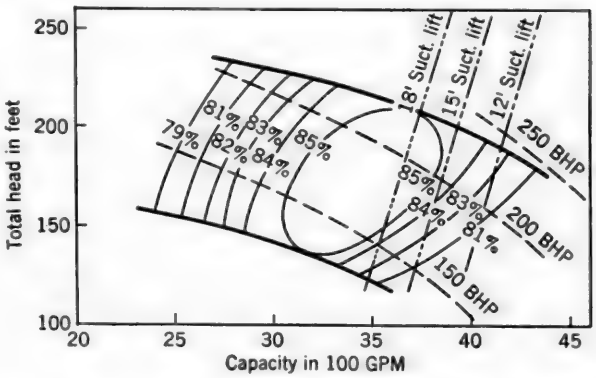

Fig. 22. Rating curve of a 10-inch double suction single stage pump.

service condition, a curve showing, for a given speed, the range in conditions that can be met by a given impeller design or by several impeller designs, is used. These are generally complicated in appearance because the efficiency that can be obtained varies with the diameter of the impeller. This variation in efficiency is covered either by iso-efficiency curves, as shown in Fig. 22, or by figures on the curves of similar points ($Q/Q_1 = \sqrt{H/H_1}$ relation) or lines approximating that relation.

For their proper use, rating curves must also show the limits of suction lift at sea level (Fig. 22) or the required minimum net positive suction head (NPSH).

Naturally, a separate chart is required for each motor speed for which the particular pump may be advantageously offered. For unusual conditions of driver speeds not covered by a curve, the use of standard relations for speed changes permit determining what the pump will do.

It should be noted that the required NPSH vs. capacity relation for a given impeller design, at a given speed, varies with the diameter to which the impeller is machined. With low specific speed types, the variation over the usable range of impeller diameter is small and a single curve can be used to apply to all diameters even though it is slightly conservative for the maximum impeller diameters. When the required NPSH vs. capacity for an impeller design varies considerably over the range of useful application of impeller cutdowns this single curve to show required NPSH is not practical and the re-

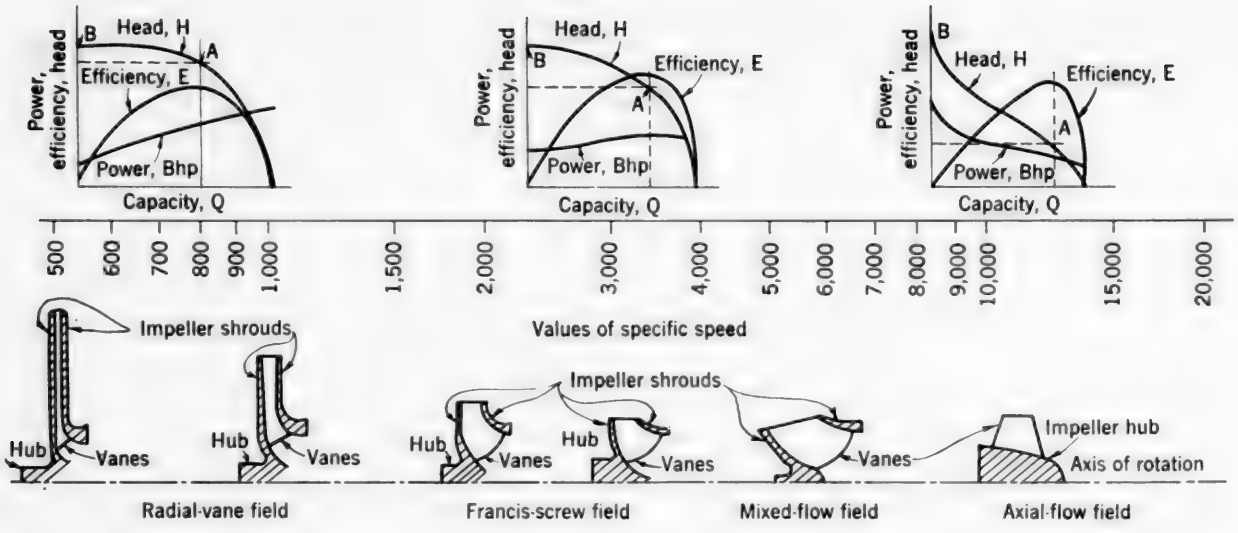

Fig. 23. Typical impeller profiles related to their specific speeds and type performance characteristics.

quired NPSH can best be shown by diagonal lines like the suction lift limit lines on Fig. 22, but labeled with NPSH values or with both suction lift and required NPSH values.

Suction Lift Limitations

If the suction lift limitation (at sea level and with 62 deg F water) for any head-capacity point of a pump is known, it is a simple matter to determine the required NPSH at that point as the NPSH is the atmospheric pressure minus vapor pressure minus suction lift. As the atmospheric pressure at sea level is 14.7 psia or 33.9 feet of 62 deg water and the vapor pressure of 62 deg water is 0.26 psia or 0.6 feet of 62 deg water, standard atmospheric pressure minus the vapor pressure is 33.3 feet of water. Thus 33.3 feet minus the indicated suction lift limit gives the required NPSH. Similarly 33.3 feet minus the required NPSH gives permissible suction lift at sea level with 62 deg water.

Specific Speed

The basic definition of specific speed is that it is the speed in revolutions per minute at which a theoretical and geometrically similar pump would run if proportioned to deliver 1 gpm against 1 foot total head with its best efficiency at these service conditions. It is therefore an index of the pump type, using the capacity and head obtained at the maximum efficiency point. It is sometimes desirable to determine the specific speed of a pump at a capacity and head other than that of best efficiency but such specific speed values should not be used as an index of the pump type.

The formula for determining specific speed is—

$$N_s = \frac{nQ^{1/2}}{H^{3/4}}$$

where N_s = specific speed
Q = gpm capacity at speed n and head H.
n = rotative speed in rpm
H = total head per stage in feet.

The normal range in specific speeds encountered in single suction impeller designs is from 500 to 15,000 with approximate impeller profiles as indicated on Fig. 24. Basically the lower the specific speed, the higher the head that can be developed per stage by the pump.

For a given total head and suction lift condition, it has been found from experience that the specific speed of a pump should be below a certain value for successful operation. The Hydraulic Institute has issued specific speed charts, one of which applies both to single stage double suction pumps and to single stage single-suction pumps with a shaft through the eye of the impeller. The other applies to single stage, single suction, mixed-flow, and axial-flow pumps. (Both charts are based on 85 deg water at sea level). These have been generally called "Specific Speed Limit Charts." It must be realized in using these charts that pumps built for the limit allowed are not necessarily the best design for the intended service and a lower specific speed type might be more economical or in some other way preferable. These charts are intended to indicate only the maximum rotative speed which experience has so far shown a centrifugal pump can be designed with assurance of a reasonable and proper operation for the anticipated combination of operating conditions. Nothing on these charts suggests that the specific speed indicated corresponds to the point of maximum operating efficiency. Pumps are normally chosen on the basis of providing a design which will operate near their maximum efficiency points. Thus even though the service conditions do not correspond with the design conditions the specific speed value is sufficiently close to the specific speed of the design conditions.

On Fig. 23 there is shown the type characteristics of a low specific speed pump, a medium specific speed pump and a high specific speed pump to illustrate how the shape of the pump characteristics change with impeller type. This is the major reason for the differences in the shape of pump characteristics. Some variation in the shape of the curves can be obtained in the design of the impeller and casing water ways, but the variation that can be thus obtained without adversely affecting the efficiency is relatively small.

AIR CONDITIONING, HEATING AND VENTILATING'S

Basic Thermodynamics of Heating and Cooling Systems

JOHN F. SANDFORT

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Those thermodynamic fundamentals which apply to heating and air conditioning engineering are reviewed, beginning with elementary concepts and developing more complex principles with examples of their application. This will be a refresher for engineers in practice as well as a guide for those who are in training in the fields of air conditioning, heating, or ventilating.

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Basic Thermodynamics of Heating and Cooling Systems

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Thermodynamics deals with energy, transformations of energy, and the properties of matter. Heating and air conditioning engineering requires a sound working knowledge of certain thermodynamic fundamentals, but fortunately, only a narrow and elementary segment of thermodynamics applies to ordinary heating and air conditioning problems. The purpose of this article is to present, in logical sequence, those necessary thermodynamic fundamentals which do apply in these fields.

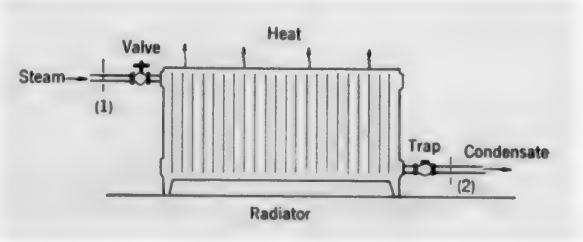


Fig. 1. A thermodynamic system.

A THERMODYNAMIC system is a region containing matter on which thermodynamic processes can be performed. Some examples of thermodynamic systems in the field of heating and air conditioning are boilers, furnaces, radiators, convectors, fans, air washers, humidifiers, cooling coils, and refrigeration condensing units. Associated fluid systems would be the flue gases, water, air, water vapor, or refrigerants flowing through the various component parts.

The system shown schematically in Fig. 1 consists of a radiator, a radiator valve, a radiator trap, and the necessary connecting pipes. The thermodynamic elements are the steam entering the radiator, the mixture of steam and water in the radiator, and the condensate leaving the radiator. The process being performed is the transfer of heat from the system to the air in the room.

Since a small amount of heat is given off by the piping connected to the radiator, in addition to that transferred from the radiator itself, an accurate assessment of this thermodynamic situation requires a knowledge of the *boundaries* of the system across which the fluid enters and leaves the apparatus. This illustrates why it is very important to always define the boundaries of any thermodynamic system under consideration. Often the boundaries are established immediately by inspection but at other times they should be fixed only after a careful consideration of those factors which could affect the accuracy or ease of solution of the problem. The nature of these factors will become apparant in the further development of this subject.

Systems are described in thermodynamic terms by evaluating the *properties* of the system, examples of which are pressure, temperature, and density. Values of these thermodynamic properties establish the *state* of the system, and consequently a system changes state when one or more of its properties change in value.

It is important that we be able to evaluate the properties of a system at its boundaries for we will see that in this way we can determine how much heat has been transferred from, or other effects produced by an apparatus and its system. Thus the boundaries of a system must be taken at those points where we are able to measure enough properties to establish the state.

For example, suppose the steam enters the radiator valve shown in Fig. 1 at some known pressure and temperature, but in passing through the valve it drops to some unknown pressure. Then the boundary of the entering steam would be taken at section (1) for only at this point could the entering state be determined. For similar reasons we would establish the boundaries of the leaving condensate at section (2).

Another fact that must be considered is that systems can exist as *solids*, *liquids*, or *gases;* the so-called *phases* of matter. The processes whereby a substance changes phase are called *melting*, *freezing*, *evaporation*, and *condensation*, all of familiar meaning. If a gas normally exists in a state near its condensation point it is usually referred to as a vapor although there is no sharp distinction made between the two terms.

It is not unusual for some systems to change phase as well as state when undergoing a process. For example, steam enters a radiator while condensate leaves, a mixture of air and water vapor enters an air conditioning apparatus where some of the water vapor condenses and leaves as a liquid while the air remains in the gaseous phase throughout the process. Usually any change of phase during a process will be apparent from a statement of the problem. In any event the phase of the medium must be known at the boundaries of the system before the properties can be determined.

It should be emphasized that in thinking of systems we should not necessarily expect them to be in neat little shapes or packages. They may be large or small, simple or complicated, a small device or section of apparatus, or a complicated assemblage of equipment through which several different fluid streams are passing simultaneously.

Pressure

Pressure is defined as the force acting on a unit area of the boundaries of a system. It is a property of any

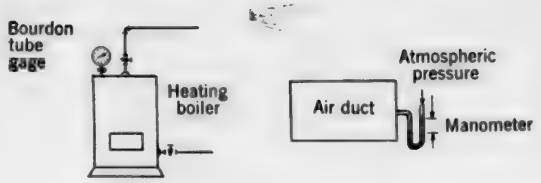


Fig. 2. Application of pressure gages.

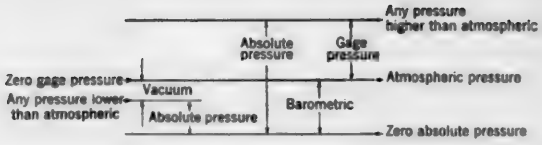


Fig. 3. Comparison of pressures.

fluid system, either gas or liquid. Pressures of the many different systems encountered in heating and air conditioning are expressed as *gage pressure, absolute pressure,* or *vacuum,* and are measured in several different units depending on the type of gage used. This is due to both custom and convenience, but in any event it is necessary to understand the meaning of these various units and to be able to convert them into different forms if and when necessary. Two different pressure gages are shown in Fig. 2.

The diagram in Fig. 3 illustrates the relationship between the various types of pressure. Atmospheric pressure, often called barometric pressure, establishes zero gage pressure, and the difference between absolute and barometric pressure is the gage pressure reading. If the absolute pressure is below the pressure of the atmosphere it is expressed as vacuum.

A barometer usually consists of a column of mercury (Hg) so arranged as to be exactly balanced by the pressure of the atmosphere. The barometric pressure then is the height of the column measured in inches or millimeters of Hg. Ordinary pressure and vacuum gages such as Bourdon tube gages, draft gages, and manometers, measure gage pressures in units of pound per square inch gage (psig), inch of water, or inch of Hg.

How this is done can be shown by referring to the manometer in Fig. 2. Air pressure in the duct is forcing the water column to rise in the manometer. However the pressure of the atmosphere is opposing this force, with the result that there is a gage pressure of one inch water gage indicated. On the other hand if the pressure in the duct had been one inch of water below atmospheric pressure, the position of the water column in the manometer would have been reversed and the state of the system would then be described as a vacuum of one inch water gage.

A summary of typical pressure gage usage found in heating and air conditioning service is shown in Table 1.

It was mentioned earlier that it is frequently necessary to convert given units of pressure into other units. One reason for this is to enable use of proper units in dimensionally homogeneous equations. Another reason is to facilitate use of charts, graphs, or tables in which the information given is in units other than those wanted.

The following constants are helpful in making unit conversions.

Density of mercury at 32 deg F = 0.491 lb per cu in.

Density of water at 60 deg = 0.0361 lb per cu in. or 62.37 lb per cu ft.

One standard atmosphere = 14.696 lb per sq in.

One inch Hg at 32 deg = 13.6085 inches water at 60 deg.

Example 1: The pressure in an air duct is 1.5 inch of water as read on a manometer. Calculate the absolute pressure in the duct in pound per square foot.

Solution:

1.5 inch water × 0.0361 lb per cu inch = 0.542 lb per sq inch.

0.542 lb per sq inch gage + 14.696 lb per sq inch = 15.238 lb per sq inch abs.

15.242 lb per sq inch × 144 sq inches per sq ft = 2195 lb per sq ft.

Example 2: A forced hot water heating circuit contains a convector with a pressure drop of 0.5 inch of Hg. The rest of the circuit has a pressure drop of 1.24 psi. Calculate the total pressure drop in the circuit, in foot of water.

Solution:

0.5 inch Hg. × 0.491 lb per cu inch = 0.245 lb per sq inch.

Total pressure drop = 0.245 + 1.24 = 1.485 psi.

For clarity in unit conversions, equations may be set up so that units can be cancelled algebraically. Thus, the next step in this solution might be written:

$$\frac{1.485 \text{ lb}}{1 \text{ in.}^2} \times \frac{1 \text{ in}^3}{0.0361 \text{ lb}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \cdots 4.94 \text{ ft of water}$$

Example 3: In order to read a particular friction drop chart it is necessary to convert 0.48 inch of Hg into inch of water. What is this conversion?

Solution:

0.48 inch Hg × 13.6085 = 6.53 inches af water

Specific Volume and Density

The *specific volume* of a substance is defined as the volume occupied by its unit mass at some specified pres-

TABLE 1—TYPICAL PRESSURE GAGE USAGE

Type of Pressure Gage	Where Used	Type of Pressure Measured	Usual Units
Bourdon Tube	Boilers Pressure Tanks Refrigeration Condensers High Pressure Piping	Gage Pressure or Vacuum	Psi In. Hg
Manometer or Draft Gage	Air Ducts Combustion Equipment Chimneys Low Pressure Piping	Gage Pressure or Vacuum	In. Water In. Hg
Barometer	Atmospheric Pressure	Absolute Pressure	In. Hg

sure and temperature. *Density* is defined as the mass per unit volume of substance. Thus, density and specific volume are dependent properties, each being the reciprocal of the other.

Both specific volume and density are widely used properties in heating and air conditioning calculations. These properties are not measured directly, like pressure, but are either read from tables or calculated by equations using other measurable properties.

The specific volume and density of liquids are affected so slighty by pressure that they are considered to be noncompressible in ordinary heating and air conditioning applications. For example, a pump circulating 10 gallons per minute (gpm) at atmospheric pressure would have its capacity reduced to only 9.983 gpm at 200 psi if the weight circulating remained constant.

However, temperature changes do affect volumes of liquids to a significant, although small, degree. Thus, hot water heating systems must have correctly sized expansion tanks to allow for the increase in the volume of the water in the system when it is heated.

On the other hand, the specific volume and density of gases are greatly affected by both pressure and temperature, and the exact relationship between these properties will be explained in detail in the following sections.

Example 4: It has been calculated that the cooling coil in an air conditioning system requires 8000 lb of 60 deg water per hr. How many gallons per minute are required?

Note: 1 cu ft = 7.481 gallon; 1 gallon = 8.33 lb.

Solution:

$$\frac{8000\ \text{lb}}{1\ \text{hr}} \times \frac{1\ \text{ft}^3}{62.37\ \text{lb}} = \frac{128\ \text{ft}^3}{1\ \text{hr}}$$

$$\frac{128\ \text{ft}^3}{1\ \text{hr}} \times \frac{7.481\ \text{gal}}{1\ \text{ft}^3} \times \frac{1\ \text{hr}}{60\ \text{min}} = \frac{16\ \text{gal}}{1\ \text{min}}$$

or,

$$\frac{8000\ \text{lb}}{1\ \text{hr}} \times \frac{1\ \text{gal}}{8.33\ \text{lb}} \times \frac{1\ \text{hr}}{60\ \text{min}} = 16\ \text{gpm}$$

Temperature

There is an important difference between temperature and the other thermodynamic properties such as pressure and specific volume. Temperature is a fundamental concept and since it cannot be expressed in terms of other dimensions it is quite difficult to formulate into a satisfactory definition.

We recognize in temperature a force or potential similar to electric voltage or a "head" of water, and this force always tends to come to equilibrium with its surroundings. This suggests that we define an *equality of temperature* rather than temperature itself. It is easy to recognize the relative "hotness" or "coldness" of a substance but before temperature can be used as a property it must be measured in exact degree for any particular system.

There are certain fixed and reproducible temperature points in nature, two examples of which are melting ice and boiling water at a fixed pressure. These fixed points make it possible to establish temperature scales and to construct thermometers.

To illustrate, a temperature scale could be constructed by first placing an unmarked mercury-in-glass thermometer in melting ice and marking the position of the mercury column. The mercury bulb would next be placed in pure boiling water at standard atmospheric pressure and the position of the mercury column again marked. Now if we divided the distance between the two marks into 180 equal divisions and labeled the ice point 32 and the boiling point 212 we would have the familiar Fahrenheit temperature scale. On the other hand if we divided the distance into 100 divisions and labeled the ice point 0 and the steam point 100 we would have the Centigrade scale.

These scales are familiar and convenient to use, but they are entirely arbitrary and tell nothing about the fundamental nature of temperature. However, there is a fundamental temperature scale that is independent of the construction of any particular thermometer. While this temperature scale has no upper limit, there is an absolute minimum or zero of temperature below which it is impossible for any system to exist. The proof of these statements is beyond the scope of this article, but it has been found that this absolute minimum of temperature occurs at about 460 degrees below zero on the Fahrenheit scale. Therefore it is necessary to add 460 to Fahrenheit temperature to convert it to the fundamental temperature scale of degrees Fahrenheit absolute (Fabs). Similarly we can convert degrees Centigrade to degrees Centigrade absolute by adding 273.

Since there are 180 degrees on the Fahrenheit scale for every 100 degrees on the Centigrade scale, and since 32 deg F is equal to 0 deg C we can convert Centigrade temperature and Fahrenheit temperature as follows:

$$t_f = 1.8\ t_c + 32$$

and

$$t_c = \frac{(t_f - 32)}{1.8}$$

also, on absolute temperature scales,

$$T_f = 1.8\ T_c$$

In the United States it is customary to use either the Fahrenheit or Fahrenheit absolute temperature scales as required for engineering problems. The notation in the balance of this article will be to indicate temperatures as 100F for 100 degrees Fahrenheit or 560 Fabs for 560 degrees Fahrenheit absolute.

When using temperature as a property we must always be aware of the difference between the common Fahrenheit scale and the fundamental Fahrenheit absolute scale, for in many thermodynamic and heat transfer equations only fundamental temperatures can be used.

Equations of State

Any two independent properties are sufficient to establish the state of a system at rest. For example, if the air in a room were at standard atmospheric pressure and at a temperature of 70F, its density would be 0.075 lb per cu ft. Then regardless of the processes that air might undergo it would always have this unique density whenever the pressure and temperature were as indicated.

Equations that show the relationship between the pressure, volume, and temperature of a system are called *equations of state* and are extremely useful in determining properties needed in the solution of problems.

A *perfect gas* is one which obeys the following equations:

(At constant pressure) $\frac{v_2}{v_1} = \frac{p_2}{p_1}$ (at constant volume) (1)

From Eq. (1) and a consideration of the fundamental temperature scale it is possible to show that the following relation exists between the pressure, volume, and temperature of a perfect gas:

$$pv = RT \qquad (2)$$

where p = pressure in lb per sq ft abs.
v = specific volume, cu ft per lb
R = gas constant ft per deg F (varies with each gas)
T = temperature, Fabs

Eq. (2) is the equation of state for a perfect gas and is often referred to as the *characteristic gas equation.*

If the system contains more than one pound of the gas, Eq. (2) may be written in the following alternate forms:

$$p(mv) = mRT \qquad (2a)$$

or

$$pV = mRT$$

where m = lb mass
V = total volume, cu ft

Values of the gas constant R for several gases and vapors are given in Table 2.

Experiments have shown that no gas *exactly* complies with the characteristic gas equation. In other words there are no perfect gases in nature although some, such as hydrogen, helium, oxygen and nitrogen closely approach perfect gas behavior.

When gases exist at states close to their condensation points they are called vapors and generally depart sufficiently from perfect gas behavior so that Eq. (2) and other "gas" equations cannot be used with acceptable accuracy. However, there is an important exception to this generalization in the case of vapors at extremely low pressures. Experiments show that *all* gases and vapors approach perfect gas behavior as their pressures approach absolute zero. This fact is of particular interest in heating and air conditioning processes since it applies to the water vapor present in the atmosphere. Whereas the total pressure of the atmosphere is usually around 14 psi, the partial pressure of the water vapor component in the air is rarely over 0.5 psi. At this low pressure water vapor can be treated as a perfect gas and the "gas" equations such as Eq. (2) may be used. This is most useful in developing equations for use in psychrometrics, which is that branch of thermodynamics dealing with atmospheric air and the water vapor it contains.

Example 5: A 12 x 20 x 8 ft room contains dry air at 72F. How many pounds of air are in the room if the atmospheric pressure is 29.5 in. Hg?

Solution: Since air may be treated as a perfect gas Eq. (2a) applies.

$$pV = mRT$$

where p = $29.5 \times 0.491 \times 144 = 2085$ lb per sq ft
V = $12 \times 20 \times 8 = 1920$ cu ft, volume of room
R = 53.3 ft per deg F from Table 2.
T = $72 + 460 = 532$ Fabs

then $2085 \times 1920 = m \times 53.3 \times 532$

and m = 141 lb of air in the room

Example 6: If the humidity of the air in the room described in Example 5 is raised until the vapor pressure becomes 0.3 psi, how many pounds of water must be evaporated?

TABLE 2—GAS CONSTANTS R FOR VARIOUS GASES

Air	53.3
Ammonia	89.5
Carbon Dioxide	34.9
Helium	386.
Hydrogen	767.
Nitrogen	55.1
Oxygen	48.3
Water Vapor	85.8

Solution: Since water vapor at low pressure may be treated as a perfect gas Eq. (2a) applies.

$$pV = m\,RT$$

where R = 85.8 ft per deg F from Table 2 and other values taken from Example 5

then $0.3 \times 144 \times 1920 = m \times 85.8$

and m = 1.82 lb of water

Example 7: Air enters a warm air furnace at 70F and at a rate of 1200 cfm. What are the cfm leaving the furnace if the air is heated to 140F? Assume that the drop in air pressure through the furnace is negligible.

Solution: Eq. (2a) applies and the units of V may be cubic feet per minute if the units of m are pound per minute. Then rearranging Eq. (2a) and using subscripts (1) and (2) to indicate the state of the air entering and leaving the furnace respectively we have:

$$\frac{p_1V_1}{T_1} = m\,R_1 = \frac{p_2V_2}{T_2}$$

But since $p_1 = p_2$ this equation can be simplified as follows:

$$V_2 = V_1\left(\frac{T_2}{T_1}\right)$$

$$= 1200\left(\frac{140 + 460}{70 + 460}\right)$$

$$= 1360 \text{ cfm.}$$

Equations of state have also been developed for water and steam and other fluids for which the perfect gas equations cannot be used. Some of these have been derived by methods using the kinetic theory of gases while others are empirical and are based on observed data. These are generally too complex to use directly in the solution of problems in the same manner that we use the characteristic gas equation. Instead the resulting properties have been computed and prepared in table form. In heating and air conditioning work it is necessary that we be able to use such tables, particularly those of water and steam but first it is necessary to have an understanding of the behavior of water and steam.

Behavior of Water and Steam

To understand more clearly the pressure-volume-temperature relationships for water and steam refer to Fig. 4 and 5. The apparatus shown in Fig. 4 is simply a

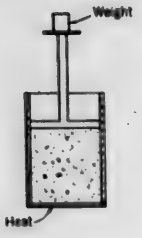


Fig. 4. Piston displacement in compression.

cylinder fitted with a freely moving piston that can be weighted to produce any desired pressure on the fluid system contained in the cylinder. Work can be done by or on this system by the raising or lowering of the weights and heat can be added or removed from the system by conduction through the bottom of the cylinder.

Suppose that the cylinder contains water at 32F and the weights on the cylinder are producing a pressure of 100 psia. If heat were now added to this system the temperature would start to rise rather rapidly and the volume would increase quite slowly as shown by the constant pressure path, (1) to (2), in Fig. 5. When the water reached a temperature of 327.8F at state (2), we would find that any additional supply of heat would cause the water to start to boil at constant temperature. Any liquid at the boiling temperature corresponding to its pressure is called a *saturated liquid*, and therefore 327.8F is the saturation temperature for water under a pressure of 100 psia. Any liquid at a temperature below its boiling temperature corresponding to its pressure is called a *subcooled liquid*. Thus a liquid can be subcooled by either lowering its temperature or increasing its pressure.

The continued addition of heat to the saturated liquid in the cylinder would cause the volume of the system to increase very rapidly along the constant pressure and temperature path, (2) to (3), as the water vaporized into steam. The change of phase would be complete at state (3) and we would then have saturated steam. Any vapor at the boiling temperature corresponding to its pressure is called a *saturated vapor*. Any point in-between saturated water and saturated steam is called a *mixture* and the percent of vapor present in the total mixture is known as the *quality* of the mixture and this is represented by the symbol x. For example, if one half of the water in the cylinder boiled into steam the resulting mixture would then have a quality of 50%, or in other words, $x = 0.50$.

The amount of heat required to change a pound of saturated water into saturated steam at a given pressure is known as the heat of *vaporization*. Any further addition of heat to saturated steam at constant pressure would result in a continuous rise of both temperature and volume as shown by path (3) to (4). This steam would now be called superheated steam. Any vapor at a temperature higher than the boiling temperature corresponding to its pressure is called a *superheated vapor*.

Critical and Triple Points

If the experiment with the apparatus shown in Fig. 4 were now repeated, but with pressures of 500 psia and 1000 psia on the piston, two different constant pressure paths could be plotted as shown in Fig. 5. If additional pressures were used we would find that the points of discontinuity could be joined in a smooth curve to form a saturated vapor line and a saturated liquid line. These two curves would approach each other as the pressure was increased and finally they would come together at the *critical point*. Thus the specific volume and density of saturated water and saturated steam are identical at the critical point. The critical pressure for water is 3206.2 psia and the corresponding critical temperature is 705.4F. Liquids can of course exist at pressures higher than their critical pressure but in this state there can be no observable change of phase from a liquid to a vapor.

Now if we set up our apparatus for a final experiment in which the cylinder contained water at exactly 32.02F and 0.08854 psia we would find that the addition and removal of heat would produce a unique phenomenon. The addition of heat would cause the water to vaporize at 32.02F while the removal of heat would cause the water to freeze or solidify into ice at 32.02F. It is interesting to note that either the addition or removal of heat to water at 32.02F will cause the specific volume to increase, and that only at this temperature can water coexist in all three phases of solid, liquid, and vapor. This temperature is called the *triple point*.

Referring to the temperature-specific volume diagram for steam and water, Fig. 5, we see that the entire area to the right of the saturated vapor line represents the superheated vapor region. Above the triple point and between the saturated vapor line and the saturated liquid line is the liquid and vapor mixture region, while the area to the left of the saturated liquid line represents subcooled liquid. Below the triple point the saturated liquid line changes to a *saturated solid* line and to the left of this line is a subcooled solid while to the right is the solid and vapor mixture region.

Steam Tables

The standard reference for determing the properties of water and steam is *Thermodynamic Properties of Steam* by Keenan and Keyes (Wiley, 1936). However, more complete and accurate data at lower temperatures were found to be necessary for the construction and compilation of accurate psychrometric charts and tables. Accordingly a cooperative project was initiated by the American Society of Heating and Ventilating Engineers for the purpose of obtaining accurate properties of water and steam in the temperature range of 200F down to −160F. These have been published in Transactions for 1945 under the title *Thermodynamic Properties of Water at Saturation* by Goff and Gratch.

Tables of thermodynamic properties of water and steam are commonly called steam tables and Table 3 is a condensation of the two tables discussed above. The properties for steam at temperatures of 100F and above have been taken from the Keenan and Keyes tables, while the properties below 100F have been taken from the Goff and Gratch tables.

The steam tables are divided into two parts: the saturation tables and the superheat tables. The saturation tables are used to determine the properties of saturated water, saturated steam, and mixtures of the two. Note that the subscript f denotes a saturated liquid, the subscript g refers to a saturated vapor, while fg denotes the

TABLE 3—STEAM TABLES—SATURATION: TEMPERATURES

Temperature deg F	Absolute Pressure Psia	Specific Volume, cu ft per lb			Enthalpy, Btu per lb		
		Sat. Liquid or Solid v_f or v_i	Evap. v_{ig} or v_{fg}	Sat. Vapor v_g	Sat. Liquid or Solid h_f or h_i	Evap. h_{ig} or h_{fg}	Sat. Vapor h_g
−20	0.0062	0.0174	42370.0	42370.0	−168.21	1220.47	1052.26
−10	0.0108	0.0174	24750.0	24750.0	−163.65	1220.32	1056.67
0	0.0185	0.0174	14810.0	14810.0	−158.98	1220.07	1061.09
10	0.0309	0.0174	9060.0	9060.0	−154.22	1219.72	1065.50
20	0.0504	0.0174	5662.0	5662.0	−149.36	1219.26	1069.02
30	0.0808	0.0175	3608.0	3608.0	−144.40	1218.69	1074.29
32	0.0886	0.0160	3304.6	3304.6	0.00	1075.16	1075.16
40	0.1216	0.0160	2445.4	2445.0	8.04	1070.64	1078.68
50	0.1780	0.0160	1704.3	1704.3	18.07	1064.99	1083.06
60	0.2562	0.0160	1207.1	1207.1	28.08	1059.34	1087.42
70	0.3630	0.0160	867.9	868.0	38.04	1053.71	1091.78
80	0.5070	0.0161	633.0	633.0	48.02	1048.07	1096.12
90	0.6984	0.0161	467.9	467.9	58.04	1042.40	1100.44
100	0.9496	0.0161	350.2	350.2	68.02	1036.72	1104.74
110	1.2754	0.0162	265.2	265.2	78.00	1031.01	1109.01
120	1.6933	0.0162	203.2	203.2	87.98	1025.28	1113.26
130	**2.2237**	0.0162	157.3	157.3	97.97	1019.50	1117.47
140	2.8900	0.0163	122.9	123.0	107.96	1013.69	1121.65
150	3.7194	0.0163	97.02	97.04	117.96	1007.83	1125.79
160	4.7424	0.0164	77.25	77.27	127.97	1001.92	1129.89
170	5.9936	0.0164	62.03	62.05	137.99	995.95	1133.94
180	7.5119	0.0165	50.20	50.22	148.01	989.93	1137.94
190	9.3403	0.0166	40.94	40.96	158.05	983.84	1141.89
200	11.526	0.0166	33.62	33.64	168.10	977.68	1145.78
210	14.123	0.0167	27.80	27.82	178.17	971.43	1149.60
212	14.696	0.0167	26.78	26.80	180.18	970.17	1150.35
220	17.186	0.0168	23.13	23.15	188.13	965.2	1153.4
230	20.780	0.0168	19.36	19.38	198.23	958.8	1157.0
240	24.969	0.0169	16.31	16.32	208.3	952.2	1160.5
250	29.825	0.0170	13.80	13.82	218.5	945.5	1164.0
300	67.013	0.0175	6.45	6.47	269.6	910.1	1179.7
400	247.31	0.0186	1.84	1.86	374.9	826.0	1201.0
500	680.8	0.0204	0.65	0.67	487.8	713.9	1201.7
600	1542.9	0.0236	0.24	0.27	617.0	548.5	1165.5
700	3093.7	0.0369	0.04	0.08	823.3	172.1	995.4
705.4	3206.2	0.0503	0.00	0.05	902.7	0.0	902.7

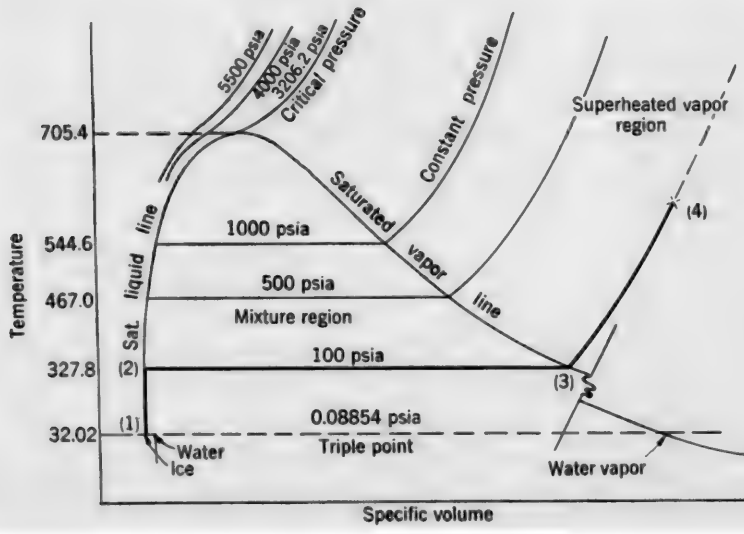


Fig. 5. Temperature-volume diagram for water and steam.

TABLE 3—STEAM TABLES (CONTINUED) SUPERHEATED VAPOR

Abs. Press., Psia (Sat. Temp.)		Sat. Liquid	Sat. Vapor	Temperature — Degrees F						
				140	180	220	260	300	340	380
1	v	0.02	333.6	356.6	380.6	404.5	428.4	452.3	476.2	500.0
(101.74)	h	69.7	1106.0	1123.3	1141.4	1159.5	1177.6	1195.8	1214.1	1232.5
5	v	0.02	73.5		75.71	80.59	85.43	90.25	95.06	99.86
(162.24)	h	130.1	1131.1		1139.4	1158.1	1176.5	1195.0	1213.4	1231.9
10	v	0.02	38.4			40.09	42.56	45.00	47.42	49.84
(193.21)	h	161.2	1143.3			1156.2	1175.1	1193.9	1212.5	1231.2
14.696	v	0.02	26.8			27.15	28.85	30.53	32.20	33.85
(212.00)	h	180.1	1150.4			1154.4	1173.8	1192.8	1211.7	1230.5
15	v	0.02	26.29			26.59	28.26	29.91	31.54	33.16
(213.03)	h	181.1	1150.8			1154.3	1173.7	1192.8	1211.7	1230.5
				240	280	320	360	400	440	480
20	v	0.02	20.09	20.48	21.74	22.98	24.21	25.43	26.65	27.86
(227.96)	h	196.2	1156.3	1162.3	1182.0	1202.1	1220.3	1239.2	1258.2	1277.1
25	v	0.02	16.30		17.33	18.34	19.33	20.31	21.29	22.26
(240.07)	h	208.4	1160.6		1180.6	1200.2	1219.4	1238.5	1257.6	1276.6
30	v	0.02	13.75		14.39	15.24	16.07	16.90	17.71	18.53
(250.33)	h	218.8	1164.1		1179.3	1199.1	1218.6	1237.9	1257.0	1276.2
40	v	0.02	10.50		10.71	11.36	12.00	12.63	13.25	13.86
(267.25)	h	236.0	1169.7		1176.5	1197.0	1216.9	1236.5	1255.9	1275.2
50	v	0.02	8.51			9.04	9.56	10.07	10.57	11.06
(281.01)	h	250.1	1174.1			1194.8	1215.2	1235.1	1254.7	1274.2
				300	340	380	420	460	500	540
60	v	0.02	7.17	7.26	7.71	8.14	8.57	8.99	9.40	9.81
(292.71)	h	262.1	1177.6	1181.6	1203.0	1223.6	1243.6	1263.4	1283.0	1302.5
70	v	0.02	6.21		6.57	6.95	7.32	7.68	8.04	8.40
(302.92)	h	272.6	1180.6		1201.0	1221.9	1242.3	1262.2	1282.0	1301.7
80	v	0.02	5.47		5.72	6.06	6.38	6.70	7.02	7.33
(312.03)	h	282.0	1183.1		1198.8	1220.3	1240.9	1261.1	1281.1	1300.9
90	v	0.02	4.90		5.05	5.36	5.65	5.94	6.22	6.51
(320.27)	h	290.6	1185.3		1196.6	1218.6	1239.5	1260.0	1280.1	1300.0
100	v	0.02	4.43		4.52	4.80	5.07	5.33	5.59	5.84
(327.81)	h	298.4	1187.2		1194.3	1216.8	1238.1	1258.8	1279.1	1299.2
				400	440	480	520	560	600	640
200	v	0.02	2.29	2.36	2.51	2.66	2.79	2.93	3.06	3.19
(381.79)	h	355.4	1198.4	1210.3	1234.9	1257.8	1279.8	1301.1	1322.1	1342.8
300	v	0.02	1.54		1.61	1.71	1.82	1.91	2.01	2.10
(417.33)	h	393.8	1202.8		1219.1	1245.3	1269.5	1292.5	1314.7	1336.4
400	v	0.02	1.16			1.24	1.32	1.40	1.48	1.55
(444.59)	h	424.0	1204.5			1231.3	1258.3	1283.3	1306.9	1329.6
500	v	0.02	0.93			0.95	1.03	1.10	1.16	1.22
(467.01)	h	449.4	1204.4			1215.4	1246.0	1273.4	1298.6	1322.6
600	v	0.02	0.77				0.83	0.89	0.95	1.00
(486.21)	h	471.6	1203.2				1232.5	1262.7	1289.9	1315.2

difference between the property of a saturated vapor and a saturated liquid. The final three columns give the values for enthalpy. This is a very useful property and will be defined and discussed later.

Since liquids are practically non-compressible at all ordinary pressures, changes in pressure produce no noticeable changes in other properties. Therefore properties of subcooled water are considered to be the same as properties of saturated water at the same temperature. Under very high pressures corrections must be made for the compressibility of water but this condition is not encountered in ordinary heating and air conditioning engineering.

Properties of mixtures can be determined from values read from the saturation tables as follows:

If

$$x = \frac{\text{lb vapor}}{\text{lb mixture}} \text{ by definition,}$$

then

$$1-x = \frac{\text{lb liquid}}{\text{lb mixture}}$$

therefore

$$v = v_f + x v_{fg}$$

$$\frac{\text{ft}^3}{\text{lb mixture}} = \left(\frac{\text{lb liquid}}{\text{lb mixture}}\right)\left(\frac{\text{ft}^3}{\text{lb liquid}}\right)$$

$$\begin{pmatrix} \text{lb vapor} \\ \text{lb mixture} \end{pmatrix} \begin{pmatrix} \text{ft}^3 \\ \text{lb vapor} \end{pmatrix}$$

or

$$v = v_f + x v_{fg} \qquad (3)$$

since by definition

$$v_{fg} = v_g - v_f$$

The superheat tables are shown in the second part of Table 3. Values for specific volume and enthalpy are given for a limited number of pressures and temperatures in the superheat region. Note that values for the saturated state are also included for a convenient reference when using these tables.

Example 8: What vacuum in inches of Hg must be maintained in a steam heating system if the radiators are to be kept at 130F? (Assume an atmospheric pressure of 14.696 psia.)

Solution: The saturation pressure corresponding to 130F is 7.51 psia as read from the steam tables:

$$14.696 - 7.51 = 7.186 \text{ psi vacuum}$$

$$\frac{7.19}{0.491} = 14.6 \text{ in. Hg vacuum}$$

Example 9: A radiator contains saturated steam at 220F. What will be the temperature of the mixture in the radiator if half of the steam condenses?

Solution: The specific volume of the final mixture will be the same as the specific volume of the initial saturated steam. This is 23.15 cu ft per lb as read from the steam tables.

Equation 3 applies,

$$v = v_f + x v_{fg}$$

However, in this case v_f can be ignored since it is quite small as compared to v_{fg}.

Therefore,

$$23.15 = 0.5\ v_{fg}$$

and

$$v_{fg} = \frac{23.15}{0.5} = 46.13 \text{ cu ft per lb}$$

The corresponding temperature for this state is 184F as read from the steam tables to the nearest degree.

Example 10: Since steam approaches perfect gas behavior at low pressures compare the specific volume of superheated steam at 1 psia and 380F as read from the steam tables with the calculated value using the characteristic gas equation $pv = RT$.

Solution: From the superheat tables, Table 3, $v = 500$ cu ft per lb calculated value using $R = 85.8$ from Table 2:

$$v = \frac{85.8 \times 840}{1 \times 144} = 500 \text{ cu ft per lb}$$

Example 11: A forced hot water heating system is equipped with a boiler in which the normal pressure is 14.7 psia. The pressure drop for the circulating water through the system is 12 ft of water. The temperature of the water entering and leaving the boiler is 180F and 200F respectively.

Determine what the state of the water entering the pump would be if it were placed in the pipe (a) entering the boiler or (b) leaving the boiler. (Assume the pump elevation would be the same in both cases.)

Solution: Since the pump must overcome the friction in the system, the *increase* in pressures through the pump is:

$$12 \text{ ft} \times 12 \frac{\text{in}}{\text{ft}} \times 0.0361 \frac{\text{lb}}{\text{in}^3} = 5.2 \frac{\text{lb}}{\text{in}^2}$$

Therefore the pressure at the suction side of the pump is,

$$14.7 - 5.2 = 9.5 \text{ psia}$$

The saturation temperature corresponding to this pressure as read from the steam tables, Table 3, is about 191F. Therefore the water entering the pump located at point (a) would be subcooled 191F − 180F = 11F but if located at point (b) the water in the boiler would flash into steam since the boiler pressure would be below the saturation pressure corresponding to the boiler temperature of 200F.

Internal Energy, Heat, and Work

The definition of thermodynamics given previously makes reference to the term energy and to transformation of energy, but no definition has as yet been given for energy. Since energy is a fundamental concept it is difficult to express it or to define it in other terms. However it may be very broadly defined as "the ability to produce a change in a system".

We recognize the existence of energy in many forms. A body has *potential energy* when it is located at some elevated position, and it has *kinetic energy* when it is moving at some finite velocity. In addition a body contains energy due to its chemical and thermodynamic properties. This energy might be released by some chemical or atomic process, or simply by the change of state of a system such as steam being condensed into water. This form of energy that is associated with a body or system because of its elevation, velocity and chemical and thermodynamic properties is known as *internal energy*.

However, in engineering thermodynamics we are ordinarily dealing with systems whose chemical composition does not change. Furthermore, if we always evaluate the internal energy of a system independently of its relative motion or elevation, we have an energy term which is dependent only upon the thermodynamic properties or the *state* of the system.Thus internal energy becomes a property itself and is given the symbol *u*.

Heat is defined as the energy that is *transferred* between systems because of a *temperature difference*. We know from experience that heat transfer always occurs when there is a temperature difference between two points and that the direction of heat flow will always be from the higher to the lower temperature. However, the mechanism of heat transfer will depend upon the nature of the intervening substance connecting the two points. For example, heat transfer occurs across a solid wall by *conduction*, while heat is transferred from the sun to the earth by *radiation*. Furthermore a radiator heats a room by both *radiation* and *convection*. The subject of heat transfer is so important in heating and air conditioning that it should be studied as a fundamental subject separate from thermodynamics.

It has been stated that thermodynamics also deals with transformation of energy. An example of such transformation involving heat and internal energy can be found in a steam heating system. Heat is transferred rapidly by conduction from the high temperature combustion gases to the water in the boiler where it is transformed into internal energy by boiling the water into steam. This energy is then carried in pipes to the radiators or other heating units connected to the boiler where it is transformed back into heat by means of condensing steam. and thus heats the various rooms of the building.

Work is defined as *energy* that is *transferred* to or from a system because of a *force* acting through a *distance*. Although work energy is extremely important in other branches of engineering it is not encountered as often as heat energy in the analysis of heating and air conditioning processes. Nevertheless, this form of energy must be recognized and handled correctly when it does occur. Examples are the work supplied to a fan in a ventilating system, a pump in a hot water heating system, or a refrigeration compressor in an air conditioning system.

Work, like all other energy, can also be transformed into different forms. For example, an electric fan circulating the air in a room is converting work into kinetic energy. Electric current is an alternate form of work energy since it can be converted into mechanical work without theoretical loss. Thus an electric strip-heater is an example of the transformation of electrical work into heat. Work is a high grade and expensive form of energy and can always be completely transformed into heat which is a low grade energy. Conversely however, it is more difficult to transform heat into work and a more advanced study of thermodynamics would show that this transformation can never be complete. In other words any heat engine, which is any apparatus for converting heat to work such as a steam power plant or an internal combustion engine will always have a work output less than the equivalent heat input when operating in a continuous manner.

That branch of engineering thermodynamics dealing with heat engines, and heat engine cycles and efficiencies, is of the greatest importance in engineering, for our very civilization is dependent upon the adequate production of power in its many forms. However, in the more limited field of heating and air conditioning, the conversions of heat into work is not encountered and so it will not be discussed further here.

Units of Energy

Since potential energy, kinetic energy, internal energy, heat, and work are all different forms of the same thing we should be able to express them quantitatively in the same units. This can be done although it is customary to express heat and internal energy in terms of *British thermal units* (Btu), and potential energy, kinetic energy, and work in terms of foot-pounds (ft-lb). A Btu is defined as the amount of heat required to raise the temperature of one pound of water at standard atmospheric pressure from 63F to 64F. A foot-pound is defined as a force of one pound acting through a distance of one foot.

It has been shown by experiment that it requires 778 foot-pound (778.26 more exactly) of work to produce 1 Btu. Hence 1 Btu = 778 ft-lb and this equality has become the commonly accepted definition of a Btu in thermodynamics.

TABLE 4—ENERGY CONVERSION FACTORS

Energy Quantities	
1 Btu	= 778 ft-lb
1 horsepower-hour (hp-hr)	= 2545 Btu
1 kilowatt-hour (kw-hr)	= 3413 Btu
Heat Transfer Rates	
1 Mbh	= 1000 Btu per hr
1 sq ft of steam radiation	= 240 Btu per hr
1 ton of refrigeration	= 12,000 Btu per hr or 200 Btu per min
Power	
1 horsepower (hp)	= 33,000 ft-lbs per min = 2545 Btu per hr = 746 watts
1 kilowatt	= 1000 watts = 3413 Btu per hr

The *rate* of heat transfer is generally expressed in Btu per hour, but in the heating and air conditioning trade several other units have also become established by custom. In the heating industry the terms Mbh (1000 Btu per hr) and *square foot of radiation, equivalent direct radiation*, or simply *Edr* (one square foot of radiation is equivalent to 240 Btu per hr) are widely used for rating equipment. In air conditioning engineering a common unit is *tons of refrigeration* (12,000 Btu per hr). It is interesting to note the origin of these units. A square foot of surface on the old column type steam radiators transferred about 240 Btu per hr in ordinary room heating service. A ton of ice melting in 24 hours will absorb heat at the rate of 12,000 Btu per hr if the latent heat of fusion is taken as 144 Btu per lb.

The *rate* of work is called *power* and is usually expressed in mechanical units as *horsepower*, (1 hp = 33,000 lb per min), or in electrical units as watts (1 watt = 3,413 Btu per hr).

Table 4 gives conversion equations for energy units commonly used in heating and air conditioning engineering.

Example 12: Referring to the cylinder and piston apparatus of Fig. 4, suppose the cylinder contained some gas to which 10 Btu of heat were added, and that during the process the piston raised a weight of 2000 lb through a distance of one foot. Calculate the increase in internal energy of the gas. (Note: Assume that the heat added is equal to the work done by the system plus the increase in internal energy of the system).

Solution:

Heat added = 10 Btu

Work done by system = 2000 ft lbs

$$= \frac{2000}{778} \quad 2.57 \text{ Btu}$$

Therefore, the increase in internal energy of the system is

$$10 - 2.57 = 7.43 \text{ Btu}$$

Example 13: An air conditioning unit contains a cooling coil and a blower. It is desired to remove 32,130 Btu per hr from the air entering the unit and the blower is being driven by a 1½-hp motor. How many tons of refrigeration must be removed by the cooling coil?

Solution: The energy *added* to the air conditioner by the blower is,

$$1\tfrac{1}{2} \text{ hp} \times 2545 \frac{\text{Btu}}{\text{hp hr}} = 3820 \text{ Btu per hr}$$

Therefore the total energy which must be removed by the cooling coil is,

32,180 + 3820 = 36,000 Btu per hr or 3 tons of refrigeration.

Example 14: A garage has a heat loss of 100,000 Btu per hr. It is desired to use a particular unit heater with a capacity of 180 sq ft Edr. How many additional Mbh will be required to heat the garage?

Solution: Heat supplied by the unit heater is

180 × 240 = 43,200 Btu per hr.

Therefore the additional Mbh required will be,

100,000 − 43,200 = 56,800 Btu per hr = 56.8 Mbh.

A process occurs whenever a system changes from one state to another. In analyzing problems involving thermodynamics it is necessary to describe the process that is work or heat are being transferred or across which any fluids are flowing.

Flow Processes

Practical heating and air conditioning processes are virtually all *flow processes*. In such processes there is a continuous flow of fluid through the apparatus where the changes of state occur. Examples of equipment in which flow processes occur are furnaces, boilers, heating and cooling coils, piping systems, valves, air washers, pumps, and humidifiers. The fluids usually encountered in this equipment are air, air-water vapor mixtures, water or steam. Usually work or heat are being transferred across the boundaries in addition to the flowing fluid, but this is not invariably true. For example, a steam humidifier represents a flow process in which a supply of steam is being mixed with a stream of air. In this case neither heat nor work are crossing the boundaries. A process which occurs without any transfer of heat across the boundaries of the apparatus is called an *adiabatic process*.

Non-Flow Processes

A *non-flow* process is one in which the fluid remains within the boundaries of the apparatus during its change of state. The processes which have previously been described in this section as occurring in cylinder and piston apparatus shown in Fig. 4 are examples of non-flow processes. Although seldom found in practical engineering processes the non-flow process is nevertheless very useful in analyzing and understanding thermodynamic problems and principles.

Reversible Processes

A *reversible process* is one which never departs from equilibrium by more than an infinitesimal amount and in which there is no friction nor turbulence. Reversibility applies to processes involving transfer of heat as well as work. Reversibility in heat transfer means that the temperature differences are in near equilibrium while mechanical reversibility indicates the near equilibrium in the opposing forces in the system. Reversibility is a very important concept in the more extensive treatments of thermodynamics. However, for the purposes of this text it will be sufficient to understand the general meaning of reversibility and what its implications are in heating and air conditioning processes.

Suppose that the cylinder in Fig. 4 contains a gas at some given volume and that the piston will move 1 ft for each 1 lb weight on the piston. Then if a 4 lb weight were placed on the piston it would compress the gas by moving down 4 ft, and 4 × 4 = 16 ft-lb of work would be used in the process. This process would not be reversible according to our definition. Placing the 4 lb weight on the piston would throw the system out of equilibrium and the resulting compression would be accompanied by oscillations of the piston and considerable turbulence in the gas.

Now if we repeated this compression process by adding the 4 lb to the piston, one pound at a time, the resulting piston displacement would still be 4 ft but the work required would now be (1 × 1) + (2 × 1) + (3 × 1) + (4 × 1) = 10 ft-lb. By repeating this compression by adding succesively smaller increments of weights it is apparent that the work required would be progressively less, and in the limiting case we would have a reversible process in which the work required would be a minimum of 8 ft-lb. A demonstration of these principles is presented in Fig. 6.

Thus, *for reversible processes the work required is always a minimum and the work performed is always a maximum.* Reversible processes are ideal processes that cannot be realized in actual machines. It is impossible to build a blower or circulating pump, for example, that will not have some friction or fluid turbulence present in its operation. But with careful design, based on engineering fundamentals, this irreversibility can be reduced to a minimum with the result that less power is required to operate the device and less noise and vibration are present in the system.

Likewise it is known that thermal reversibility also results in thermodynamic advantages. For example, the irreversibility of an air cooling process would be measured by the temperature difference between the refrigerant in the cooling coil and the air being cooled. It can be shown that the power requirements of a refrigeration compressor would become less if the cooling coil were operated at a temperature nearer that of the air being cooled and so approach a thermally reversible condition of operation.

It is evident, however, that neither thermal nor mechanical irreversibility can be reduced without a price. In the case of heat transfer equipment the reduction of temperature difference means additional heat transfer surface will be necessary to maintain the same cooling or heating capacity. In the case of the blower and pump previously mentioned, more care must be given to their design and greater precision maintained in their manufacture. The engineer, whether he is designing heating, ventilating, or air conditioning systems, or their component equipment, must constantly recognize the compromise that must be made between performance and initial cost.

TABLE 5—SPECIFIC HEATS OF GASES AND VAPORS

Gas or Vapor	Specific Heat at Constant Volume C_v Btu per lb deg F	Specific Heat at Constant Pressure C_p Btu per lb deg F
Air	0.172	0.240
Ammonia	0.399	0.523
Carbon Dioxide	0.156	0.206
Hydrogen	0.244	0.342
Nitrogen	0.176	0.246
Oxygen	0.155	0.217
Water Vapor	0.334	0.444

Specific Heat

The specific heat of a substance is defined as the amount of heat required to raise the temperature of one pound of the substance one degree Fahrenheit when undergoing some specified non-flow process. The following equation results from this definition of specific heat.

$$c = \frac{Q}{m(t_2 - t_1)}$$

or

$$Q = mc(t_2 - t_1) \qquad (4)$$

where Q = heat transferred for the process, Btu
m = mass, lbs
c = average specific heat for the process, Btu per (lb) (deg F)
t = temperature, F

Since there is no limitation on the value or sign of *Q* and *t* the specific heat *c* can have any value from positive to negative infinity. For practical purposes, though, there are only two processes for which the specific heat is of particular importance, namely, the constant volume and the constant pressure processes.

Then for a constant volume process Eq. (4) has the following special form,

$$Q = mc_v (t_2 - t_1) \qquad (4a)$$

where c_v is specific heat at constant volume, Btu per (lb) (deg F), and for a constant pressure process,

$$Q = mc_p (t_2 - t_1) \qquad (4b)$$

where c_p is specific heat at constant pressure, Btu per (lb) (deg F).

To illustrate, consider again the apparatus shown in Fig. 4. Suppose the cylinder contained one pound of air and that the piston was fixed. Under these conditions we would find that 0.172 Btu of heat would be required to raise the temperature of the pound of air one degree F. or $c_v = 0.172$ Btu per (lb) (deg F). If next we allowed the piston to move freely against atmospheric pressure we would find that now 0.24 Btu of heat would be required to raise the temperature of the system one degree F, or $c_p = 0.240$ Btu per (lb) (deg F). The increase in specific heat for the constant pressure process would be expected since additional energy would be required to do the work of "pushing back" the atmosphere.

For all ordinary processes involving the heating or cooling of solids and liquids, the specific heat at constant pressure (c_p) is used rather than the specific heat at constant volume (c_v). In fact, tables giving specific heats of solids and liquids usually make no reference to the type of process although the constant pressure process is assumed. Actually, any ordinary variation in pressure on solids and liquids has a negligible effect on the other properties of the substance.

Tests show that c_p and c_v for gases are practically constant but the specific heat of liquids and solids vary somewhat with temperature.

Table 5 gives specific heat values for various gases and vapors while Table 6 gives specific heat values for certain liquids and solids.

Example 15: A cast iron radiator weighing 200 pounds is filled with 60 pounds of water. How much heat will be given off to the room if the radiator valve is shut off and the system is allowed to cool down from 190F to 72F?

Solution: From Table 6 we note that the specific heat of cast iron is 0.12 Btu per (lb) (deg F) while the specific heat of water is about 1.00 Btu per (lb) (deg F) for the average temperature of this process.

Then using Eq. (4), $Q = mc(t_2 - t_1)$

Heat transferred from the radiator,

$$Q = 200 \times 0.12 \times (190 - 72) = 2830 \text{ Btu}$$

Heat transferred from the water,

$$Q = 60 \times 1.00 \times (190 - 72) = 7080 \text{ Btu}$$

Total heat given off = 2830 + 7080 = 9910 Btu

Example 16: It is estimated that a certain church contains 192,000 pounds of brick, 75,000 pounds of stone concrete, and 140,000 pounds of wood (80,000 pounds of fir and 60,000 pounds of oak). The church structure has been allowed to cool down an average of 20 degrees on a cold winter day. How long would it take to raise the temperature of the structure and the enclosed air back to the design temperature if the heating plant has an excess pickup capacity of 150,000 Btu per hour?

The volume of the church is 18,000 cubic feet.

Solution: From Tables 5 and 6, c_p for air = 0.24,

TABLE 6—SPECIFIC HEATS OF LIQUIDS AND SOLIDS

Liquid	Specific Heat Btu per (lb) (deg F)	Solid	Specific Heat Btu per (lb) (deg F)
Alcohol, Ethyl 32-104 F	0.60	Aluminum	0.22
Alcohol, Methyl 40-80 F	0.60	Asbestos	0.20
Ammonia, 32 F	1.10	Brick	0.22
Calcium Chloride Sp. Gr. 1.20	0.73	Carbon	0.17
Fuel Oil, Sp. Gr. .96	0.40	Concrete, Stone	0.19
Fuel Oil, Sp. Gr. .91	0.44	Concrete, Cinder	0.18
Fuel Oil, Sp. Gr. .86	0.45	Copper	0.09
Fuel Oil, Sp. Gr. .91	0.50	Glass, Common	0.20
Gasoline	0.53	Glass, Plate	0.12
Glycerine	0.58	Ice	0.49
Kerosene	0.98	Iron, Cast	0.12
Sea Water, Sp. Gr. 1.024	0.94	Iron, Wrought	0.12
Turpentine	0.41	Lead	0.03
Water, 40 F	1.005	Lime Stone	0.22
Water, 80 F	0.998	Porcelain	0.26
Water, 120 F	0.997	Steel	0.12
Water, 160 F	1.000	Sandstone	0.22
Water, 200 F	1.004	Tile, Hollow	0.15
		Wood, Fir	0.65
		Wood, Oak	0.57
		Wood, Pine	0.67

c for brick = 0.22. c for fir = 0.65, c for oak = 0.57, c for stone concrete = 0.19.

First calculate the specific volume of the air,

$$v = \frac{RT}{p} \qquad (2)$$

$$v = \frac{53.3 \times (70 + 460)}{14.7 \times 144} = 13.3 \text{ cu ft per lb}$$

(assuming 70 F and standard atmospheric pressure)

Then the weight of air in

$$\text{the church} = \frac{18{,}000}{13.3} = 1350 \text{ lbs}$$

Next calculate the amount of heat required to raise each component part 20 degrees.

$$Q = mc\,(t_2 - t_1) \qquad (4)$$

for the air.

$$Q = 1350 \times 0.24 \times 20 = 6{,}500 \text{ Btu}$$

for the brick.

$$Q = 192{,}000 \times 0.22 \times 20 = 845{,}000$$

for the concrete.

$$Q = 75{,}000 \times 0.19 \times 20 = 285{,}000$$

for the fir.

$$Q = 80{,}000 \times 0.65 \times 20 = 1{,}040{,}000$$

for the oak.

$$Q = 60{,}000 \times 0.57 \times 20 = 685{,}000$$

$$2{,}861{,}500 \text{ Btu}$$

Therefore the time required to reheat the structure would be.

$$\frac{2{,}861{,}500}{150{,}000} = 19.1 \text{ hours}$$

Note that the heat required to raise the temperature of the air is not significant in this problem.

The First Law of Thermodynamics

A process was described in Example 12 wherein the heat added to the air in a cylinder was assumed to be equal to the increase in the internal energy of the air plus the work done by the piston. This assumption, which allowed us to solve the problem, is based upon a great fundamental principle upon which a large part of the science of thermodynamics is based. This principle is called the *First Law of Thermodynamics* and may be stated as follows. *Energy can neither be created nor destroyed, but it can be converted into different forms by a system undergoing a process.*

It is interesting to note that this principle cannot be proved in a mathematical sense but it is assumed to be true because no exception has ever been found in any system to which it has been applied nor has any concept based upon it ever been shown to be false. Even the seeming exceptions in nuclear physics conform.

The *general energy equation* is the application of the First Law of Thermodynamics to any system undergoing a non-flow or a steady-flow process and may be stated in the following manner. *The energy entering a system equals the energy leaving the system plus or minus the net change of energy within the boundaries of the system.* When the general energy equation is applied to non-flow processes it is known as the *non-flow energy equation* and may be stated symbolically as follows:

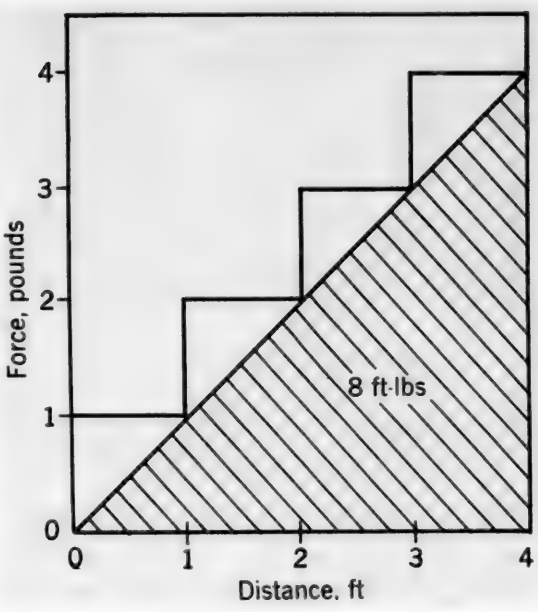


Fig. 6. Demonstration of work.

$$Q = u_2 = u_1 + \frac{W}{J}$$

where Q = heat added to the system, Btu per lb.
u = internal energy at the state indicated, Btu per lb.
W = work done by the system, ft lb per lb.
J = 778 ft lb per Btu, a constant for converting ft lb to Btu.

The non-flow energy equation is useful in solving any type of non-flow process but it has perhaps its greatest utility in the development of other equations and properties useful in thermodynamics. Eq. (5) will be referred to in this manner from time to time throughout this chapter.

The general energy equation is of the greatest use to engineers, however, as a tool in the solution of flow processes, and its use in this manner is described in detail in the following article.

The Steady Flow Energy Equation

In applying the general energy equation to flow processes we find more variables involved than in the case of non-flow processes. We now have a transfer of mass as well as a transfer of heat and work across the boundaries of the system and each pound of the working fluid entering and leaving the apparatus contains different forms of energy.

It is convenient in thermodynamics to consider a special kind of flow process, known as a *steady flow process.* This process is defined as one in which (1) the properties of the fluid crossing the boundaries of the apparatus do not change in value, (2) heat and work cross the boundaries at a constant rate, and (3) the mass rates of flow (lb per sec) entering and leaving the apparatus are equal. This process is of particular interest because most

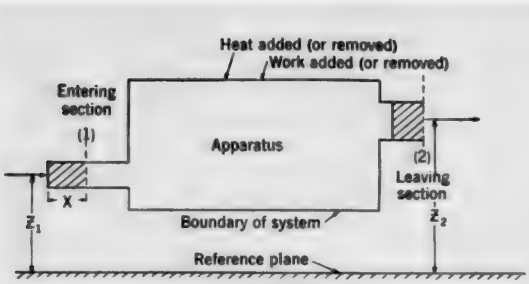


Fig. 7. Steady flow apparatus.

of our actual processes closely approximate it in practice and the general energy equation can be applied to it in such a way as to greatly simplify the solution of flow problems.

For an illustration of the general steady-flow process refer to the flow diagram in Fig. 7. The apparatus shown is schematic but could represent any heating or air conditioning equipment. To conform to the conditions of steady flow the states of the fluid at sections (1) and (2) will not change with time although they will not necessarily be the same. The pounds of fluid per second entering at section (1) will equal the pounds per second leaving at section (2) and each of these pounds will contain a certain amount of potential energy, kinetic energy, and internal energy as discussed previously. Note that the boundaries of the apparatus are extended to include the pound of fluid about to cross section (1) as well as the pound of fluid just leaving at section (2). This allows us to apply the general energy equation to the steady flow process during the time that one pound of the fluid enters the apparatus and another pound simultaneously leaves. During this time the entering boundary has shifted to section (1) while the leaving boundary has moved beyond section (2) so as to include the fluid that has just left the apparatus.

The potential energy contained in each pound of the fluid crossing the boundaries is measured by the feet of elevation z above some reference plane, and has the units of foot-pounds per pound mass. It is assumed that a *mass* of one pound will also *weigh* one pound.

The kinetic energy contained in each pound is the energy due to the velocity of the mass and it can be shown that this is equal to $V^2/2g$ ft-lb per lb; where V is velocity of the fluid, ft per sec, and g is acceleration due to gravity, 32.2 ft per sec^2.

The internal energy u, contained in each pound, is the energy in the fluid due to the position and motion of the molecules and is usually expressed in units of Btu per pound.

The total energy which is carried into the apparatus by one pound of the fluid is,

$$\frac{z_1}{J} + \frac{V^2_1}{2gJ} + u_1 \text{ Btu per lb}$$

where the subscript 1 refers to the entering section of the boundary where the properties are measured and the conversion factor J is used to change foot-pounds into Btu.

Likewise, the energy carried out of the apparatus is

$$\frac{z_2}{J} + \frac{V^2_2}{2gJ} + u_2 \text{ Btu per lb}$$

Next, if we are to account for all the forms of energy in the steady flow process we must recognize that work is required to force each pound of fluid across section (1) into the apparatus, and also across section (2) out of the apparatus. The force required is the product of the pressure (p in lbs per sq ft) times the cross-sectional area of the pipe (a in sq ft) at the respective sections. Then the work required is the product of this force times the distance (X in ft) through which it must act to move the pound across the section. (See Fig. 7.)

This work is called *flow work* and is equal to paX ft-lb per lb or simply pv, since the specific volume (v in cu ft per lb) of the fluid is equal to aX.

As a final possible transfer of energy, heat Q and work W may cross the boundaries of the apparatus somewhere between sections (1) and (2). It is customary to express heat in units of Btu and work in units of foot-pounds. Work in a steady-flow process is sometimes called *shaft work* to distinguish it from *flow work*. It is usually recognized as energy flowing along a shaft to which power equipment, such as a motor, is attached.

With all energy forms accounted for we can now apply the general energy equation to this steady-flow process. From the definition of such a process we see that there can be no accumulation of energy in the system during the process and therefore the general energy equation reduces to the following form:

The energy entering a system = The energy leaving the system

The various energy forms in this equation can be expressed with symbols as previously defined,

$$\frac{z_1}{J} + \frac{V_1^2}{2gj} + u_1 + \frac{p_1v_1}{J} + Q + \frac{W}{J} = \frac{z_2}{J} + \frac{V^2_2}{2gj} + u_2 + \frac{p_2v_2}{J} \qquad (6)$$

in which each term has the units of Btu per pound of fluid passing through the apparatus. Note that the heat and work terms will be either plus or minus depending on whether the energy is being added or removed.

Equation (6) is known as the *steady-flow energy equation* and is one of the most powerful tools in engineering thermodynamics. It is very important that this equation be thoroughly understood, for various modifications of it are used extensively in the various phases of heating, ventilating, and air conditioning engineering.

It is usually desirable to shorten and simplify Eq. (6) by combining and eliminating certain terms which are not significant in the solution of particular steady-flow problems. This can be done as follows.

It is possible to combine the properties of u and $\frac{pv}{J}$ into a single composite property since they always appear together in the steady flow energy equation. This composite property is called enthalpy and has been given the symbol h. Enthalpy is sometimes called *total heat* or *heat content* although these terms are now considered obsolete in thermodynamics.

Thus, by definition, $h = u + \frac{pv}{J}$ (7)

and substituting Eq. (7) in Eq. (6) we have,

$$\frac{z_1}{J} + \frac{V^2_1}{2gJ} + h_1 + Q + \frac{W}{J} = \frac{z_2}{J} + \frac{V^2_2}{2gJ} + h_2 \qquad (6a)$$

In many actual steady-flow processes the differences between the elevation and velocity of the fluid entering and leaving the apparatus are not large enough to be significant and so may be omitted from the steady-flow equation. If in addition the process is adiabatic Eq. (6a) reduces to the following form,

$$\frac{W}{J} = h_2 - h_1 \qquad (6b)$$

On the other hand if no shaft work is involved in the process but heat transfer is occurring Eq. (6a) reduces to the following form,

$$Q = h_2 - h_1 \qquad (6c)$$

Example 17: 150 lb of air per min enter a blower at a velocity of 600 fpm (10 fps) and are discharged at a velocity of 3000 fpm min (50 fps). The change in elevation between the inlet and discharge of the fan is negligible, the process is adiabatic, steady flow, and the enthalpy of the air increases by 0.48 Btu per lb. What is the hp required?

Solution: Since the velocity changes are significant Eq. (6a) should be used.

$$\frac{z_1}{J} + \frac{V^2_1}{2gJ} + h_1 + Q + \frac{W}{J} = \frac{z_2}{J} + \frac{V^2_2}{2gJ} + h_2$$

rearranging,

$$\frac{W}{J} = \frac{(z_2 - z_1)}{J} + \frac{(V^2_2 - V^2_1)}{2gJ} + (h_2 - h_1) - Q$$

$$= 0 + \frac{50^2 - 10^2}{2 \times 32.2 \times 778} + 0.48 - 0$$

$$= 0.528 \text{ Btu per lb of air}$$

converting units,

$$\frac{0.528 \text{ Btu}}{\text{lb air}} \times (150 \times 60) \frac{\text{lb air}}{\text{hr}} \times \frac{1}{2545} \frac{\text{hp hr}}{\text{Btu}} = 1.87 \text{ hp}$$

The Continuity Equation

It is customary to state the quantity of fluid passing through different pieces of equipment in the particular units characteristic to that equipment. For example, fans and blowers are customarily rated in cubic feet per minute (cfm), pumps in gallons per minute or per hour (gpm) or (gph), and heating mains in pounds of steam per hour.

Consequently the units in which the problem is stated or in which the answer is desired are usually different than those units for which the energy equation is set up, in which case they must be converted into other homogeneous forms. Thus mass rates of flow must frequently be computed from velocities, pipe diameters, and densities.

For steady-flow processes when a single completely filled pipe enters and leaves the apparatus the following relation must always hold true for any section of the entering or leaving pipe regardless of its size:

$$wv = Va \qquad (8)$$

where w = mass rate of flow, lb per sec
V = velocity of fluid, ft per sec
a = cross-sectional area of pipe, sq ft
v = specific volume of the fluid, cu ft per lb

Eq. (8) is called the *continuity equation* of steady flow and is very useful in arranging data in a form necessary for use in the steady-flow energy equation. The following examples illustrate how this equation is used.

Example 18: In Example 17, 150 lb of air per min are discharged from a fan at 3000 fpm (50 fps). If the temperature of the air is 120F and the pressure is 14.7 psia, what must the diameter of a circular duct be to maintain this same velocity?

Solution: First calculate the specific volume of the air from the relation $pv = RT$.

$$v = \frac{53.3 \times (120 + 460)}{14.7 \times 144} = 14.6 \text{ cu ft per lb}$$

Next calculate the necessary cross-sectional area of the duct using the continuity equation (8),

$$a = \frac{wv}{V}$$

$$\frac{150}{60} \times \frac{14.6}{50} = 7.3 \text{ sq ft}$$

Then calculate the diameter thus,

$$\frac{\pi D^2}{4} = 7.3$$

and

$$D = 3.05 \text{ ft or } 36.6 \text{ in.}$$

Example 19: A pump is circulating 8 gpm of 180 F water through a one-inch pipe (inside diameter). What is the average velocity of the water in the pipe? (Note: 1 gal = 0.1337 cu ft).

Solution: Cross-sectional area of pipe $= \frac{\pi \times 1}{4 \times 144}$ = 0.00546 sq ft. Mass rate of water flowing = 8 × 0.1337 = 1.0696 cu ft per min. Then, rearranging the continuity equation (6),

$$V = \frac{wv}{a}$$

$$= \frac{8 \times 0.1337}{60 \times 0.00546}$$

$$= 3.26 \text{ ft per sec}$$

Internal Energy and Enthalpy for Perfect Gases

A classical proposition in thermodynamics, known as *Joules Law*, states that *the internal energy of a perfect gas is a function of temperature only*. Thus, for any perfect gas,

$$u = f(t)$$

The form of this function can be determined from the

application of the non-flow energy equation to a constant volume process, in which case,

$$u_2 - u_1 = c_v (t_2 - t_1) \qquad (9)$$

It should be remembered that Eq. (9) is valid only for perfect gases and that changes in internal energy are determined rather than absolute values. This offers no difficulty however since differences in internal energy can be used directly in both the non-flow and steady-flow energy equations. Note also that although Eq. (9) contains the term C_v it is not limited to constant volume processes but is valid for determining the change in internal energy between any two arbitrary states (1) and (2). From Joules Law we have seen that the internal energy of a perfect gas is a function of temperature only. Also from the characteristic gas equation we note that the product of the pressure times the volume of a perfect gas is a function of its absolute temperature. Therefore we can conclude that the enthalpy of a perfect gas is also a function of temperature only since $h = u + \frac{pv}{J}$ by definition. Thus,

$$h = f(t)$$

The form of this function can be derived by applying the non-flow energy equation to a constant pressure process.

Thus.

$$Q = u_2 - u_1 + \frac{p(v_2 - v_1)}{J}$$

Rearranging.

$$Q = \frac{(u_2 + p_2v_2)}{J} - \frac{(u_1 + p_1v_1)}{J}$$

Substituting Eq. (7)

$$Q = h_2 - h_1$$

But Q is also equal to $c_p (t_2 - t_1)$ from the definition of specific heat, and therefore,

$$h_2 - h_1 = c_p (t^2 - t^1) \qquad (10)$$

Again it should be thoroughly understood that Eq. (10) is valid only for *perfect gases*, but it is not restricted to constant pressure processes even though the term c_p appears in the equation. Since enthalpy is a property any equation indicating its change between two states is independent of the process connecting the two states.

A useful relationship between the specific heat at constant pressure, the specific heat at constant volume and the gas constant for a particular gas can now be developed. Substituting RT for pv in Eq. (7) we have,

$$h = u + \frac{RT}{J}$$

Differentiating this expression,

$$dh = du + \frac{R}{J} dt$$

But from Eq. (9) and (10) we note that $du = c_v dt$ and $dh = c_p dt$. Therefore,

$$c_p dt = c_v dt + \frac{R}{J} dt$$

and,

$$c_p - c_v = \frac{R}{J} \qquad (11)$$

A further useful relationship between specific heats is found in the fact that the ratio c_p/c_v = a constant for gases of similar molecular structure. Thus $c_p/c_v = 140$ for most diatomic gases such as air.

Example 20: Calculate the specific heat at constant pressure c_p for air if the gas constant R = 53.3.

Solution: Using Eq. (11) we have:

$$c_p - c_v = \frac{53.3}{778}$$

and since $c_p/c_v = 1.40$ for air,

$$c_p - \frac{c_p}{1.40} = \frac{53.3}{778}$$

and therefore

$$c_p = \frac{1.40 \times 53.3}{0.40 \times 778} = 0.240$$

Example 21: Referring to Example 17 in which the enthalpy of the air increased by 0.48 Btu per lb, what is the temperature of the air discharged from the fan if the entering air is at 60 F?

Solution: Since air behaves closely as a perfect gas and since the increase in enthalpy is known, we can use Eq. (10) to calculate the rise in temperature of the air.

Thus, $h_2 - h_1 = c_p (t_2 - t_1)$

$0.48 = 0.24 (t_2 - 60)$

$t_2 = 62$ F

Note that there has been a 2 F rise in the temperature of the air although no *heat* has been added to the system.

Internal Energy and Enthalpy of Vapors and Liquids

The enthalpy and internal energy of vapors, liquids, and mixtures of the two must be determined from vapor tables. As previously discussed, the steam tables (Table 3) are available for determining the properties of water and steam. The columns headed h_f and h_g in the saturation tables give the enthalpy of saturated liquid and saturated vapor respectively.

Note that the enthalpy of saturated water at 32 F is 0. This is an arbitrary designation and all other enthalpies in the steam tables are actually enthalpy differences measured above or below this base. Thus the enthalpy of water or steam above 32 F is always some positive number while the enthalpy of ice must be shown as a negative number.

The enthalpy of a *mixture* is given by the equation,

$$h = h_f + xh_{fg} \qquad (12)$$

This equation is derived in the same manner as Eq. (3).

The term h_{fg} is the numerical difference between h_g and h_f determined at the same pressure or temperature. This term is called the *heat of vaporization* and is defined as the amount of heat required to evaporate a pound of saturated liquid during a non-flow constant pressure process. This can be shown as follows.

Consider a constant pressure process during which a

pound of saturated water is evaporated into saturated steam. The non-flow energy equation applies.

$$Q = u_g - u_f + \frac{p(v_g - v_f)}{J}$$

Where the subscripts g and f are used since the initial state is a saturated liquid and the final state is a saturated vapor. Then rearranging and simplifying the above equation.

$$Q = \left(u_g + \frac{p_g v_g}{J}\right) - \left(u_f + \frac{p_f v_f}{J}\right)$$
$$= h_g - h_f$$

Therefore,

$$Q = h_{fg}$$

The internal energy of water and steam is not given directly in Table 3 since this property is seldom used in the solution of practical problems. However the internal energy of water in any phase can be determined by first finding the properties of enthalpy, pressure, and specific volume, and then solving for internal energy with the following equation,

$$u = h - \frac{pv}{J}$$

This equation is a rearrangement of Eq. (7).

Example 22: A steam boiler contains 10 cu ft of water at 70 F and is equipped with an oil burner which has a heating capacity of 200,000 Btu per hr. Neglecting incidental losses to boiler metal, flue gases, etc., and following thermodynamic procedures outlined, how long would it take to evaporate 40% of the water into the attached piping and heating system? The final temperature of the system is 218 F.

Solution: This is a non-flow process in which the boiler and attached piping become the boundaries of the system. The non-flow energy equation applies and therefore the initial and final internal energies must be determined in order to solve for the heat added.

$$u_1 = h_{f,1} - \frac{p_1 v_{f,1}}{J}$$
$$= 38.04 - \frac{0.3631 \times 0.016 \times 144}{778}$$
$$= 38.04 \text{ Btu per lb}$$

$$h_2 = h_f + x\, h_{fg}$$
$$= 186.11 + (0.40 \times 966.5) = 572.71 \text{ Btu per lb}$$

$$v_2 = v_f + x\, v_{fg}$$
$$= 0.01676 + (0.40 \times 23.99) = 9.613 \text{ cu ft per lb}$$

therefore

$$u_2 = 572.71 - \frac{16.533 \times 144 \times 9.613}{778}$$
$$= 543.26 \text{ Btu per lb}$$

$$Q = u_2 - u_1 + \frac{W}{J}$$
$$= 543.26 - 38.04 + 0$$
$$= 505.22 \text{ Btu per lb}$$

The total weight of water in the boiler can be calculated by dividing the total volume by the specific volume of water at 70 F as determined from the steam table.

Thus,

$$\frac{10}{0.01605} = 623 \text{ lb}$$

Then the time required for the process is,

$$623 \text{ lb} \times 505.22 \frac{\text{Btu}}{\text{lb}} \times \frac{1}{200{,}000} \frac{\text{hr}}{\text{Btu}} = 1.57 \text{ hr}$$

The Solution of Steady Flow Problems

We should now have an understanding of the steady-flow energy equation, the methods of evaluating enthalpies and the various energy terms in the equation, and the use of the continuity equation for rearranging data into a usable form. It is the purpose of this article to show a useful technique for solving problems using these methods.

The following procedure is typical for analyzing and solving problems involving steady-flow processes in heating, ventilating, and air conditioning equipment. The boundaries of the system are first established, then all the forms of energy crossing these boundaries are noted, and finally all the known properties of the fluid streams and the amount of heat and work crossing the boundaries are recorded.

The steady-flow energy equation is then applied to the process with all terms that do not apply or that have an insignificant effect on the answer being dropped out. Known values are next substituted into the remaining terms making sure that all the terms of the equation are dimensionally homogeneous. The equation is then solved for the unknown term making use of the continuity equation if and where necessary.

A little experience in solving steady-flow problems will show which terms can be eliminated from the steady-flow energy equation because they have an insignificant effect on the answer. The following problem illustrates this point.

Example 23: Let the schematic drawing of Fig. 7 represent the boundaries of a warm air heating apparatus in which 400 cfm enter at section (1) with a velocity of 600 fpm and a temperature of 70 F. Heat is then added to the air and ½ horsepower shaft work is supplied to a blower in the apparatus. The air leaves at section (2) 10 ft above section (1) through a duct 2 ft square and at a temperature of 140 F. The atmospheric pressure is 14.2 psia. Calculate the amount of heat that must be supplied in Btu per hr.

Solution: An accurate accounting of all the energy terms in this problem will require the use of the steady-flow energy equation in the form of Eq. (6a). Some of the energy terms are insignificant to the answer but all will be included in this solution to show the order of magnitude of all the terms.

$$\frac{z_1}{J} + \frac{V_1^2}{2gJ} + h_1 + Q + \frac{W}{J} = \frac{z_2}{J} + \frac{V_2^2}{2gJ} + h_2 \quad (6a)$$

Rearranging Eq. (6a)

$$Q = \frac{(z_2 - z_1)}{J} + \frac{V^2_2 - V^2_1)}{(2gJ)} + (h_2 - h_1) = \frac{W}{J}$$

Next calculate the necessary terms from the given data:

$$V_1 = \frac{600}{60} = 10 \text{ ft per sec.}$$

using Eq. (2),

$$\frac{53.3 \times 530}{14.2 \times 144} = 13.81 \text{ cu ft per lb}$$

using Eq. (8),

$$\frac{4000}{60 \times 13.81} = 4.82 \text{ lb per sec}$$

using Eq. (2),

$$v_2 = 13.81 \times \frac{600}{530} = 15.64 \text{ cu ft per lb}$$

using Eq. (8),

$$V_2 = \frac{4.82 \times 15.64}{4} = 18.85 \text{ ft per sec}$$

using Eq. (10),

$$h_2 - h_1 = 0.24\ (140 - 70) = 16.8 \text{ Btu per lb}$$

Converting the work term to consistent units,

$$\frac{W}{J} = 0.5 \text{ hp} \times \frac{25.45 \text{ Btu}}{\text{hp hr}} \times \frac{1 \text{ hr}}{3600 \text{ sec}} \times \frac{1 \text{ sec}}{4.82 \text{ lb}}$$

$$= 0.073 \text{ Btu per lb}$$

substituting the known values,

$$Q = \left(\frac{10 - 0}{778}\right) + \left(\frac{18.85^2 - 10^2}{50{,}000}\right) + 16.8 - 0.073$$

$$= 0.0128 + 0.0051 + 16.8 - 0.73 = 16.85 \text{ Btu per lb}$$

therefore,

$$Q' = 16.89 \times 4.82 \times 3600 = 293{,}000 \text{ Btu per hr}$$

where Q′ = Btu per hour

It is interesting to note that the sum of the potential and kinetic energy terms and the work added affected the answer by only about 0.3% and could have been ignored in the solution. In this case the steady-flow equation would have simplified to Eq. (6c),

$$Q = h_2 - h_1$$

Many steady-flow processes are such that the difference in fluid elevation and fluid velocity can be ignored, although occasionally this is not true. The following two examples illustrate processes where either the potential or kinetic energy terms are significant.

Example 24: 400 lb of water per minute are to be pumped through a vertical distance of 50 ft. How many horsepower will be required if we neglect any friction losses in the pipe, that is, assuming a reversible process?

Solution: In this case the nozzle is the steady-flow device. The process is adiabatic, no shaft work is performed, and there is no change in elevation of the air. Consequently Eq. (6a) can be simplified to the following form,

$$\frac{V^2}{2gJ} + h_1 = \frac{V^2_2}{2gJ} + h_2$$

or

$$c_p\ (t_1 - t_2) = \frac{V^2_2 - V^2_1}{2gJ}$$

since air behaves closely as a perfect gas Eq. (10) can be used to eliminate $(h_1 - h_2)$.

$$c_p\ (t_1 - t_2) = \frac{V^2_2 - V^2_1}{2gJ}$$

Substituting known values,

$$0.24\ (60 - t_2) = \frac{500^2 - 10^2}{50{,}000}$$

$$t^2 = 39.2 \text{ F}$$

In Example 25 the leaving velocity of 500 ft per sec produced an important kinetic energy term, but the entering velocity of 10 ft per sec was insignificant to the final result and could have been ignored.

In analyzing steady-flow processes it is usually possible to determine by inspection all of the terms that can be dropped out of the energy equation. When in doubt however they should always be left in.

The Throttling Process

Whenever a fluid is flowing in steady-flow across a restriction in such a way that the entering and leaving velocities are equal, and neither work nor heat is being transferred, the process is called a *throttling process.* Some examples of throttling processes are valves and orifice plates in steam and water lines and dampers in air ducts. Note that the velocity of a fluid undergoing a throttling process in a pipe may be quite high in the restriction, but this kinetic energy is immediately dissipated by turbulence in the down stream section of the pipe and the velocity reduces to about the same value as that for the fluid entering the restriction. It is here that the boundaries must be taken.

Throttling processes may occur as undesirable restrictions in a pipe or duct system, and since they are completely irreversible they could result in serious losses in energy and objectionable noises due to the resulting turbulence. In other cases, throttling processes may be deliberately used to control mass rates of flow, balance duct and pipe systems, etc.

When we apply the steady-flow energy equation to the throttling process we see that all the terms are eliminated with the exception of enthalpy. Thus Eq. (6a) reduces to

$$h_1 = h_2 \qquad (13)$$

Note that when a perfect gas undergoes a throttling process Eq. (10) applies, in which,

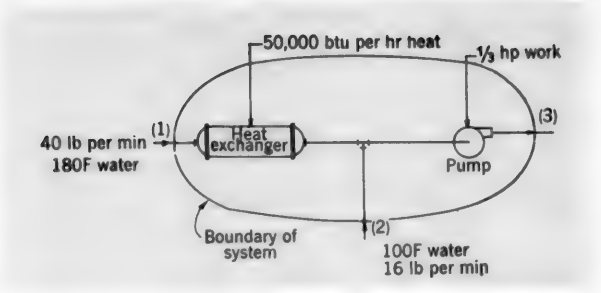


Fig. 8. Steady flow system with multiple streams.

$$h_1 - h_2 = 0 = c_p (t_1 - t_2)$$

and therefore

$$t_1 = t_2$$

However, when liquids, mixtures, or vapors are throttled to lower pressures Eq. (10) does not apply of course and there is a decrease in temperature as well as a change in other properties. This is illustrated in the following examples.

Example 26: A domestic hot water system has become overheated and contains saturated water at 225 F. Determine the condition of this water as it would come from a faucet. Assume an atmospheric pressure of 14.7 psia.

Solution: Water flowing through a faucet would be a throttling process and so Eq. (13) would apply. Thus, $h_1 = h_2 = 193.17$ Btu per lb for saturated water at 225 F.

But the water leaves the faucet at atmospheric pressure and the enthalpy of saturated water at 14.7 psia is only 180.07 Btu per lb. Therefore some of the water would flash into steam and the final state would be a mixture.

Use Eq. (12) to calculate the quality,

$$\begin{aligned} h_2 &= h_f + x\, h_{fg} \\ 193.17 &= 180.07 + x\ (970.3) \\ x &= 1.35\% \end{aligned}$$

The final temperature would be the saturation temperature corresponding to 14.7 psia or 212 F.

Steady-flow Processes with Multiple Streams

The units of each term of the steady-flow energy equation as used in this discussion have been in Btu per lb of the fluid passing thru the apparatus. For those cases where the energy units are normally given in ft lbs the constant J was introduced to convert the ft lbs into Btu. However, the energy equation could just as well have been written in any units as long as the resulting form remained *dimensionally homogenous*. Thus when multiple fluid streams enter or leave a system the respective energy terms must be expressed either as *rates* or in terms of *unit mass of one of the streams*, in order to obtain a homogeneous equation.

As an illustration refer to Fig. 8. This is a schematic drawing of a steady-flow system consisting of a heat exchanger, a circulating pump, and a piping system including two mixing water streams. From an inspection of the system we note that the potential and kinetic energy terms can be eliminated, but the steady-flow energy equation in the form given in Eq. (6a) cannot be used because of the two streams of water entering the system. However, the general energy equation for steady flow still applies, thus,

$$\text{energy in} = \text{energy out}$$

or stated symbolically as rates,

$$w_1 h_{f,1} + w_2 h_{f,2} + Q'' + \frac{W'}{J} = (w_1 + w_2)\, h_{f,3} \quad (14)$$

where Q'' = heat transfer, Btu per min

$\frac{W'}{J}$ = work, Btu per min

$$\left(\frac{\text{lb}}{\text{min}} \times \frac{\text{Btu}}{\text{lb}}\right) + \left(\frac{\text{lb}}{\text{min}} \times \frac{\text{Btu}}{\text{lb}}\right) + \left(\frac{\text{Btu}}{\text{min}}\right) + \left(\frac{\text{ft lbs}}{\text{min}} \times \frac{\text{Btu}}{\text{ft lbs}}\right) = \left(\frac{\text{lb}}{\text{min}}\ \frac{\text{Btu}}{\text{lb}}\right)$$

The application of this equation to the solution of a problem is shown in the following example.

Example 27: Calculate the temperature of the water leaving the system at state (3) in Fig. 8. The heat and work entering the system and the properties of the water at states (1) and (2) are given in the illustration. Assume that the system is at atmospheric pressure.

Solution: The steady-flow energy equation can be used of each term is expressed as a rate.

$$w_1 h_{f,1} + w_2 h_{f,2} + Q' + \frac{W'}{J} = (w_1 + w_2)\, h_{f,3}$$

Values of h_f are read from the steam tables and the values of Q' and W' are taken from Fig. 8.
Hence,

$$(40 \times 147.92) + (16 \times 67.97) + \frac{50{,}000}{60} + \frac{2545}{3 \times 60} = (40 + 16)\, h_{f,3}$$

Therefore,

$$h_{f,3} = 140 \text{ Btu per lb}$$

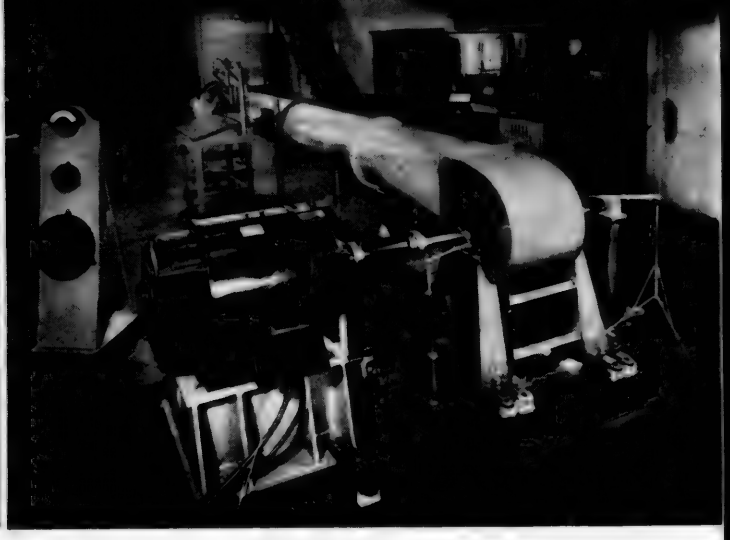
and the corresponding temperature of water having an enthalpy of 140 Btu per lb is 172 F as read from the steam tables.

Steady-flow processes may be made up on any number of different fluid streams. They may involve gases or liquids or both. In air conditioning systems the working medium is usually a combinaton of air, water, and air water-vapor mixtures, and frequently we find the water changing phase in the apparatus.

An air water-vapor mixture may enter an air conditioning apparatus where some of the water condenses and leaves as a liquid, and the remaining air leaves at some different composition. Air may enter an air washer where water is evaporated into the air and again a different mixture leaves.

Regardless of the apparent complexity of the system though, the steady-flow energy equation gives us a powerful yet simple tool for obtaining the solution.

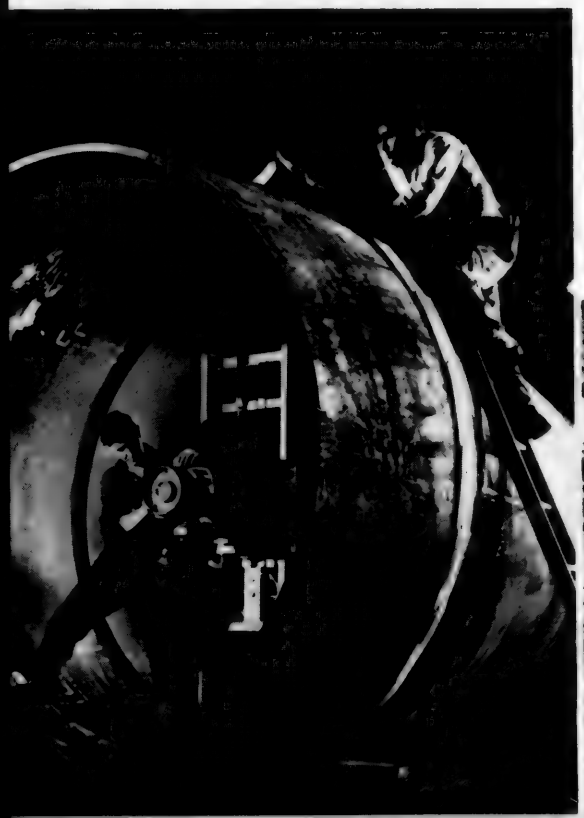
A sound study room at the new Westinghouse plant in Staunton, Va., is supported entirely by 108 coil springs. The unusual room within 8-in. thick concrete walls is a part of the development laboratories of the Air Conditioning Division. Studies in the room enable engineers to determine the origin and frequency of noise in air conditioning equipment.



Development of an efficient multiple-blade fan for silent operation at various speeds and resistance conditions was simplified by the use of a small Baldwin torque pickup unit which measures torque directly by means of a strain gage coupled between driving motor and fan. Fan test set-up is in the Detroit laboratory of American Blower Corp.

Picture Paragraphs

(Left) In a nation-wide test in actual houses to determine heating and cooling costs, Owens-Corning Fiberglas Corp. predicts that this house located in the Southern Great Lakes region can be heated for $84.80 and cooled for $18.80 in an average year. The house has three bedrooms and 1,273 square feet of floor space. Similar test dwellings in other cities are in the planning stage.



(Left) Radiographing huge pressure vessels to detect possible flaws in welds is one of the first assignments of the Gamma-ray projector recently introduced by M. W. Kellogg Co. Positioned inside pressure vessel, the projector sends a penetrating beam through the substance of the vessel to expose photographic film attached to the vessel's exterior.

(Below) Crews preparing to insulate a section of 14-in. seamless steel pipe made by Jones & Laughlin which will carry hot water at 380 deg F and 400 psi to heat buildings of the U. S. Air Force Strategic Air Base at Plattsburgh, N. Y. Pipe will be imbedded in concrete mixed with an exploded mica product and will serve buildings of the Base from a central station.

HEATING PLANT OPERATING HOURS AND LOAD FACTOR

Location	No. of Hours Intermittent Heating Plant Operates per Normal Year	Seasonal Load Factor, Normal Year, Per-Cent
ALABAMA		
Anniston–A	1129	24.5
Birmingham–A	1214	26.2
Mobile–A	771	20.2
Mobile–C	732	20.2
Montgomery–A	929	22.0
Montgomery–C	851	21.1
ARIZONA		
Flagstaff–A	2401	30.5
Phoenix–A	1023	27.5
Phoenix–C	894	25.0
Prescott–A	1452	24.9
Tuscon–A	1069	27.0
Winslow–A	1509	26.3
Yuma–A	651	24.0
ARKANSAS		
Fort Smith–A	1387	30.9
Little Rock–A	1189	26.5
Texarkana–A	1030	25.1
CALIFORNIA		
Bakersfield–A	1273	29.3
Beaumont–C	1938	35.1
Bishop–A	2254	39.3
Eureka–C	3180	36.3
Fresno–A	1521	33.0
Los Angeles–A	1612	27.3
Los Angeles–C	1154	25.3
Oakland–A	2181	24.9
Red Bluff–A	1527	32.3
Sacramento–A	1939	37.4
Sacramento–C	1777	35.1
San Diego–A	1253	23.3
San Francisco–A	2742	31.3
San Francisco–C	2453	28.0
San Jose–C	1452	24.8
Santa Catalina–A	1360	21.8
Santa Maria–A	2339	26.7
COLORADO		
Colorado Springs–A	1735	26.2
Denver–A	1730	26.6
Denver–C	1653	25.1
Grand Junction–A	1735	30.0
Pueblo–A	1523	24.7

Location	No. of Hours Intermittent Heating Plant Operates per Normal Year	Seasonal Load Factor, Normal Year, Per-Cent
CONNECTICUT		
Bridgeport–A	2022	32.4
Hartford–A	2110	33.3
New Haven–A	2065	32.1
DELAWARE		
Wilmington–A	1816	32.2
DISTRICT OF COLUMBIA		
Silver Hill Obs.	1682	30.2
Washington–A	1604	29.7
Washington–C	1573	29.4
FLORIDA		
Apalachicola–C	787	22.0
Jacksonville–A	744	22.0
Jacksonville–C	665	21.0
Orlando–A	515	13.0
Pensacola–C	863	23.8
Tallahassee–A	916	24.3
Tampa–A	460	20.6
GEORGIA		
Athens–A	1224	26.7
Atlanta–A	1863	26.5
Atlanta–C	1863	26.4
Augusta–A	929	22.5
Columbus–A	1045	24.2
Macon–A	982	24.2
Rome–A	1371	28.7
Savannah–A	909	23.1
IDAHO		
Boise–A	1888	28.4
Lewiston–A	2195	34.0
Pocatello–A	2394	34.4
ILLINOIS		
Cairo–C	1389	28.8
Chicago–A	2018	33.5
Moline–A	2042	34.3
Peoria–A	1946	32.7
Springfield–A	1822	31.5
Springfield–C	1669	30.5

A–Airport station C–City station

Seasonal Load Factor = No. Hrs. Plant Operates per Yr. ÷ No. Hrs. in Heating Season

Location	No. of Hours Intermittent Heating Plant Operates per Normal Year	Seasonal Load Factor, Normal Year, Per-Cent
INDIANA		
Evansville–A	1610	26.3
Fort Wayne–A	2013	32.9
Indianapolis–A	1795	30.9
Indianapolis–C	1643	29.9
South Bend–A	2239	36.3
Terre Haute–A	1839	32.6
IOWA		
Burlington–A	1954	33.5
Davenport–C	1832	31.8
Des Moines–A	1933	32.6
Des Moines–C	1884	32.3
Dubuque–A	2052	31.9
Sioux City–A	1979	32.6
KANSAS		
Concordia–C	1700	30.8
Dodge City–A	1619	29.2
Topeka–C	1577	29.6
Wichita–A	1463	27.7
KENTUCKY		
Bowling Green–A	1577	29.2
Lexington–A	1840	32.9
Louisville–A	1641	30.8
Louisville–C	1578	30.3
LOUISIANA		
Baton Rouge–A	855	22.7
New Orleans–A	703	20.2
New Orleans–C	625	19.3
Shreveport–A	1131	28.9
MAINE		
Eastport–C	2637	30.1
Portland–A	2625	36.1
MARYLAND		
Baltimore–A	1702	30.3
Baltimore–C	1548	26.0
Frederick–A	1662	30.1
MASSACHUSETTS		
Boston–A	2138	34.0
Nantucket–A	2245	31.5
Pittsfield–A	2463	34.1

Location	No. of Hours Intermittent Heating Plant Operates per Normal Year	Seasonal Load Factor, Normal Year, Per-Cent
MICHIGAN		
Alpena–C	2584	35.3
Detroit–A	2045	32.9
Escanaba–C	2597	34.9
Grand Rapids–A	2263	34.8
Grand Rapids–C	2072	33.2
Lansing–A	2238	34.8
Marquette–C	2726	36.4
Muskegon–A	2266	33.6
Sault Ste. Marie–A	2676	32.6
MINNESOTA		
Duluth–A	2646	35.0
Duluth–C	2526	33.0
Minneapolis–A	2222	35.2
Rochester–A	2282	34.7
Saint Cloud–A	2375	34.6
Saint Paul–A	2205	34.8
MISSISSIPPI		
Jackson–A	1058	25.2
Meridian–A	1020	23.6
Vicksburg–C	871	22.0
MISSOURI		
Columbia–A	1635	29.5
Kansas City–A	1563	29.6
Saint Joseph–A	1709	31.5
Saint Louis–A	1737	32.6
Saint Louis–C	1651	32.0
Springfield–A	1502	27.1
MONTANA		
Billings–A	1894	27.6
Butte–A	2751	31.4
Great Falls–A	2129	28.9
Havre–C	2081	29.1
Helena–A	2329	31.2
Helena–C	2297	30.1
Kalispell–A	2271	29.3
Miles City–A	1875	27.9
NEBRASKA		
Grand Island–A	1895	32.1
Lincoln–A	1952	33.2
Lincoln–C	1871	32.9
Norfolk–A	2122	34.4
North Platte–A	1847	29.6

(Table Concluded on next month's Data Sheet)

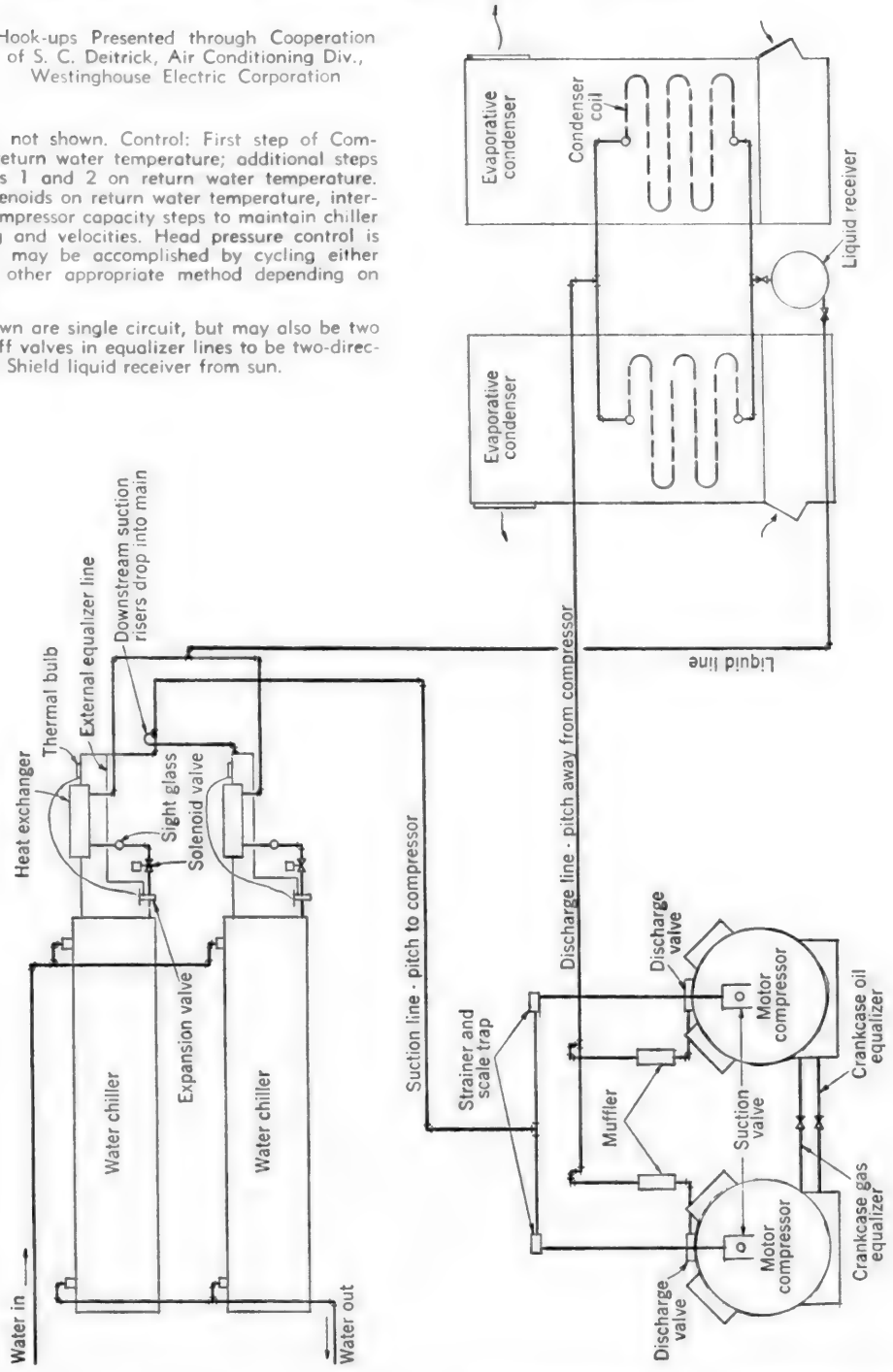
DUAL COMPRESSOR HOOK-UP

Two Refrigerating Compressors Paralleled with Two Evaporative Condensers and Two Water Chillers

Hook-ups Presented through Cooperation of S. C. Deitrick, Air Conditioning Div., Westinghouse Electric Corporation

Control piping not shown. Control: First step of Compressor 1 on return water temperature; additional steps of Compressors 1 and 2 on return water temperature. Liquid line solenoids on return water temperature, interlocked with compressor capacity steps to maintain chiller circuit loading and velocities. Head pressure control is necessary and may be accomplished by cycling either condensor, or other appropriate method depending on load balance.

Chillers shown are single circuit, but may also be two circuit. Shut-off valves in equalizer lines to be two-direction, full flow. Shield liquid receiver from sun.

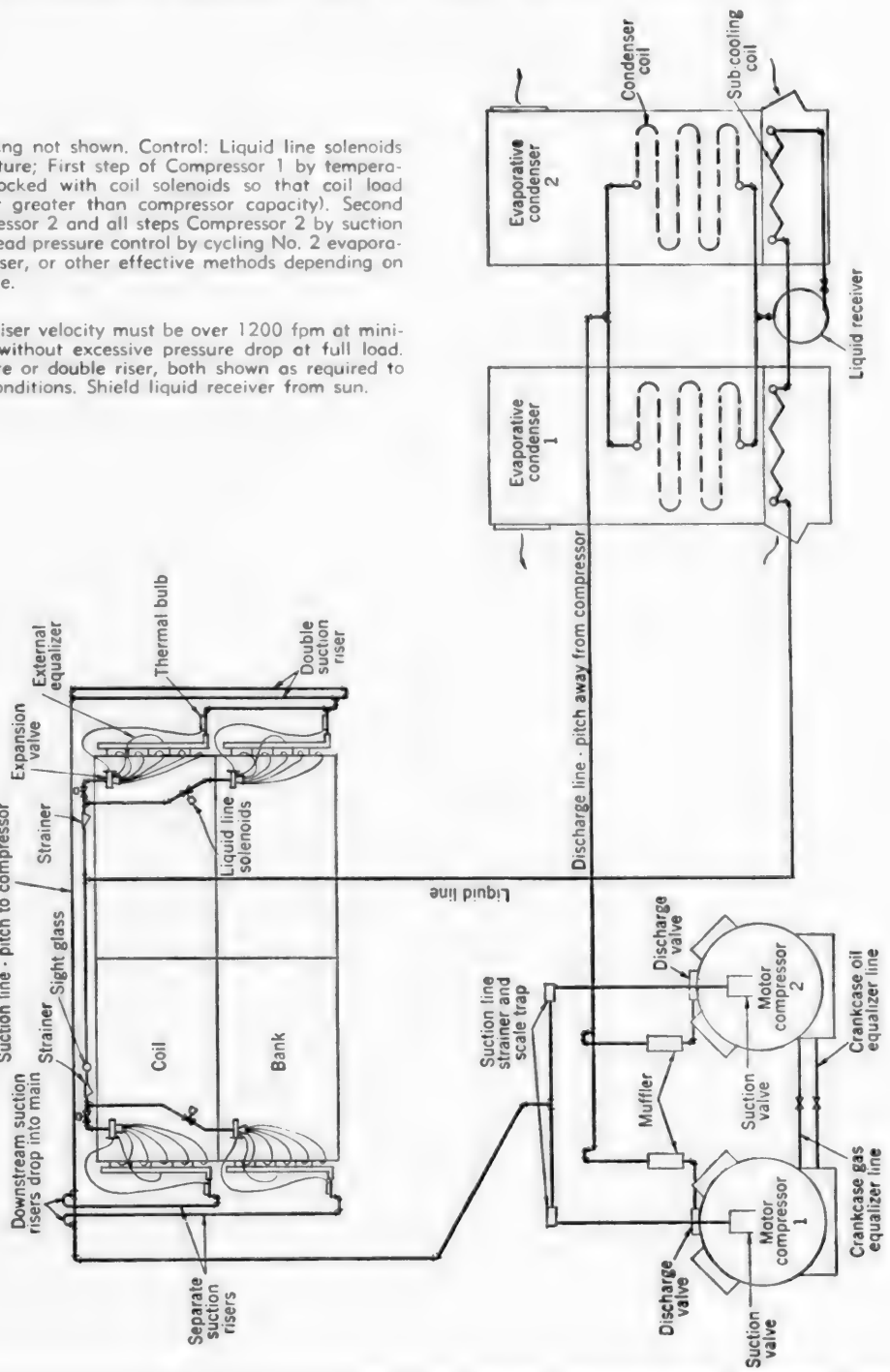


DUAL COMPRESSOR HOOK-UP

Two Refrigerating Compressors Paralleled with
Two Evaporative Condensers and Two Banks of Direct Expansion Coils

Control piping not shown. Control: Liquid line solenoids by temperature; First step of Compressor 1 by temperature (interlocked with coil solenoids so that coil load equal to or greater than compressor capacity). Second step Compressor 2 and all steps Compressor 2 by suction pressure. Head pressure control by cycling No. 2 evaporative condenser, or other effective methods depending on load balance.

Suction riser velocity must be over 1200 fpm at minimum load without excessive pressure drop at full load. Use separate or double riser, both shown as required to suit load conditions. Shield liquid receiver from sun.



Below and on the following pages are given brief digests of the advertisements appearing in this month's issue. Use this Digest to locate and refer to the advertisements in which you are particularly interested, then fill out and mail the prepaid postcard to request further information from manufacturers.

The items appear in the same order as the advertisements to which they refer, to facilitate obtaining further information after reading an advertisement.

NOTE: All advertisements are digested here except those received too late for inclusion. The Index of Advertisers lists all the advertisements in this issue.

Use the postcard below for catalogs, new equipment and materials, as well as Ad-Digest items.

STEAM TRAPS. Inside front cover. The steam traps offered by this company prevent the carbonic acid formation that corrodes unit heaters because they discharge condensate at steam temperature and vent carbon dioxide and air at the same time. The company's sizing recommendations are based on actual performance of the traps under operating conditions. Selection and installation bulletin is available. ---------- **Item 106**

SPLIT-HOUSING FAN. Page 1. A split-housing fan is manufactured by this company to exhaust corrosive fumes. The fan motor is outside of the exhaust stream. Bulletin is available. ---------- **Item 107**

HEATING SPECIALTIES. Page 4. The line of heating specialties made by this company includes pressure safety relief valves, feed water pressure regulators, boiler water feeders, low water cutoffs, and feeder cutoff combinations. A catalog of the complete line and a folder on boiler water level controls are available. **Item 108**

TEMPERATURE REGULATORS. Page 9. Four of this company's self-operating temperature regulators have been controlling the steam supply to a 10,000-gal. water heater in a Pittsburgh hospital since 1930. A valve stem lubricator aids movement of the valve stem without binding, and double ply metal is used in the bellows. Bulletin is available. ---------- **Item 109**

HOT WATER HEATING. Page 11. A zoned, two-pipe, forced hot water heating system, designed by this company, passes a small quantity of high temperature water thereby reducing the size of pipes and pumps and permits the tubing to serve as supply and return piping, eliminating mains, trenches, coverings, and runouts. Publication is available. ---------- **Item 110**

SCHOOL HEATING EQUIPMENT. Pages 12-13. School heating equipment is designed and built by this company to fire light oil, heavy fuel oil or mixed, manufactured or natural gases, or a combination of oil and gas. Seven modern schools built in one section of Pennsylvania are examples of the acceptance of the company's equipment. Information is available. ---------- **Item 111**

GLASS FIBER INSULATION. Page 14. In the world's largest fabricated steel building, 300,000 sq ft of this company's glass fiber insulation is used. Only one of the plant's three boilers is needed to maintain 75 deg F interior for over 3000 employes. Bulletins are available. ... **Item 112**

ADD-ON COOLING UNITS. Page 15. Horizontal and vertical evaporators and remote waterless compressors are available from this company to provide central cooling for homes with existing or new forced air furnaces. Both the compressors and evaporators are available in 2, 3, and 5-ton sizes for Freon 12 or 22. Information is available. ---------- **Item 113**

Circle numbers corresponding to the items and advertisements in which you are interested, print your name and address clearly. Information will be sent directly from manufacturers.

AIR CONDITIONING LINE. Between pages 16-17. The line of air conditioning equipment made by this company includes fan-coil and induction units for multi-room applications, packaged water chillers in eight models, centrifugal compressors from 3 to 1500 tons, and self-contained air conditioners in sizes to 7½ hp. Fans and air handling units are also made. Literature on the line of equipment is available. ---------- **Item 114**

CAST IRON BOILERS. Page 17. The heat and hot water for a 102-unit motor court is supplied by two of this company's cast iron boilers which had already served a hospital for twenty-five years. The boilers have vertical cast iron water tubes which are an integral part of the unit. Information is available. ---------- **Item 115**

HEATING SPECIALTIES. Page 20. The line of heat specialties offered by this company includes packless radiator valves, thermostatic radiator traps, vents, bucket traps, and boiler gages in addition to a variety of other traps. Heating specialties catalog is available. ---------- **Item 116**

CONTROLLED HEATING SYSTEMS. Pages 22-23. Controlled heating systems are offered by this company in five types to cover the range of vacuum and vapor heating requirements. Heating system specialties and power specialties for medium and high pressures are also made by this company. Bulletins are available. ---------- **Item 117**

DRAIN PIPE. Page 24. High silicon iron, specified by architects and engineers for permanent corrosive waste disposal lines, is used by this manufacturer for its drain pipe. The pipe is suitable for schools, hospitals, laboratories, commercial kitchens, and wherever permanent waste disposal lines are required. Information is available. ---------- **Item 118**

AIR CONDITIONING CONTROL. Page 25. Year-round control of a large Texas bank building's 1500 individual room air conditioning units is maintained by 640 of this manufacturer's pneumatic summer pipe in winter thermostats. The company offers pneumatic systems for individual space temperature control. Information is available. ---------- **Item 119**

GALVANIZED DUCT STEEL. Pages 26-27. Six sheet metal contractors throughout the Middle West comment on the advantages of this company's galvanized sheet steel for duct work. The continuous galvanizing process eliminates the brittle iron-zinc layer that causes galvanized coatings to flake. ---------- **Item 120**

BOILER-BURNER UNITS. Page 28. The boiler-burner units made by this company are rated on nominal capacity with reserve to take care of central needs, fluctuating loads, and future expansion. A boiler rated on maximum capacity, operating at constant top speed, requires more maintenance. Information is available. **Item 121**

INQUIRY CARD

Circle below item numbers on which you wish catalogs or further information.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105					
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149
150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171
172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191		

PLEASE PRINT June H-56

This service available only to U. S. and Canadian readers.

Name ..... **Title** .....

Firm .....

Nature of Firm's Business .....

Street .....

City ..... **Zone** ..... **State** .....

This card is void after Sept. 1, 1956

Ad-Digest

VACUUM SYSTEM VALVES. Page 30. The 12-in. packless iron body valves made by this company maintain a vacuum of less than 25 microns absolute pressure after two years of vacuum service in a light metals refinery. The valves are made in a variety of body and trim materials in ½- to 12-in. sizes. Literature is available. **Item 122**

PROPELLER FAN VENTILATORS. Page 31. Three types of propeller fan ventilators featuring steel venturi type inlet orifice are offered by this company for small to medium size buildings. Two of the fans are roof type, the third is installed in the wall. Bulletins on each type are available as well as a bulletin on heavy duty models. **Item 123**

COOLING TOWERS. Page 32. A low silhouette cooling tower for commercial and institutional capacities is offered by this manufacturer. The towers are designed with the experience of hundreds of installations and with thirty-five years of specialization in cooling tower design. Information is available. **Item 124**

BALL BEARINGS. Page 33. Ball bearings in rubber cylindrical cartridges are made by this company for air conditioning and heating equipment. Cartridges are available to interchange with other makes, while other cartridges are available to fit sleeve bearing brackets. A 6-page bulletin with dimensions and load ratings is available. **Item 125**

STEAM GENERATORS. Page 35. Packaged fire tube boilers are made by this company with an integrated and built-in induced draft system that maintains a negative pressure in all four passes of the boiler. The steam generators are built in 18 sizes from 20 to 600 bhp for pressures to 250 psi, burning oil or gas or both. Catalog is available. **Item 126**

AIR CONDITIONING SYSTEM. Page 36. The moving parts of this company's air conditioning system are dynamically balanced to reduce sound to a whisper. The system is engineered to lower installation and maintenance costs and to provide peak performance. Information is available. **Item 127**

AUTOMATIC PACKAGED BOILERS. Page 37. Automatic packaged boilers are offered by this manufacturer for low pressure steam or hot water heating for a wide variety of commercial and industrial requirements for heating loads up to 25 hp for any requirements within its capacity range. Bulletin is available. **Item 128**

SHOWER MIXING VALVES. Page 38. The shower mixing valve made by this company consists of a valve, stops, and checks with strainers as one unit concealed behind a dial plate, yet accessible. Exposed parts are finished in polished chrome; internal parts are stainless steel. Information is available. **Item 129**

AIR HANDLING EQUIPMENT. Page 39. Seventy-five of this company's fans and twenty-two of its air conditioning units were selected for the fully air conditioned Socony Mobile office building in New York. The company manufactures air handling equipment for plants, hotels, institutions, stores, and public buildings. Information is available. **Item 130.**

CEILING AIR CONDITIONERS. Page 40. Two of this company's ceiling type air conditioning units supply the cooling for a novel air conditioning system in an oyster storage room. Each unit has a 4,000 cfm capacity at 4 inches of water static pressure. Information and literature are available **Item 131**

DUCT LINER. Page 41. A spray coated duct liner is made of long textile type glass fibers by this manufacturer. Its friction coefficient compares favorably with that of unlined metal ducts. An 8-page technical brochure on thermal and acoustical duct insulation is available **Item 132**

AIR FILTERS. Page 42. Substitute air filters means contributions to the junk pile and higher cost. Get air filters that handle more air with a greater dirt-holding capacity. These filters with their heavier frames, reinforcing rods, and other features insure that each unit will continue to operate. Complete catalog information is available. **Item 133**

FEEDER-CUTOFF CONTROL. Page 43. Feeder-cutoff control combinations made by this company for boilers give both mechanical and electrical safety. The combination eliminates the pitfalls of manual filling and makes the boiler water level as automatic as the firing. Catalog is available. **Item 134**

AIR FILTERS. Page 44. A filter engineer discusses electronic air cleaners, air filter performance data, and the rated capacity of automatic viscous curtain type air filters. Information on air filters is available **Item 135**

AIR MIXERS AND DIFFUSERS. Page 45. An acoustically lined chamber made by this company blends the hot and cold air supplied to it at from 3500 to 6000 fpm. The air then passes through an air diffuser where it is mixed with room air to the desired temperature. A new products bulletin and selection manual are available. **Item 136**

CENTRAL SYSTEMS. Page 46. A central system using this company's air conditioning equipment combats unusual temperature changes for an Oklahoma building with 28,000 sq. ft. of glass area. Packaged air conditioners are also made by the company. Information is available. **Item 137**

FLOW CONTROL VALVE. Page 47. Combination straight-angle pattern, flow control valves are available from this company in sizes 1, 1¼, and 1½ in., replacing the same sizes in individual straight and angle patterns. The valve can be installed in either horizontal or vertical, forced hot water, heating pipe lines. Information is available. **Item 138**

PACKAGED BOILERS. Page 48. The 1955 record of this company's packaged boiler in a dye mill was three shifts a day, six days a week without a single unscheduled outage. The boiler assists in the full-production operation of the plant by meeting every steam need. Information is available **Item 139**

WELDING FITTINGS. Between pages 48-49. The complete line of welding fittings and flanges offered by this company simplifies the engineering, purchasing and installation of piping jobs. A booklet with information on piping, fitting, and flanging materials is available. **Item 140**

INSULATED PIPING SYSTEMS. Page 50. Early planning with one of this company's field representatives on central heating or air conditioning systems will mean less work later on. The company's engineering service for insulated piping systems is available for early planning and consultation. Catalog is available. **Item 141**

CONDENSATION PUMPS. Page 51. The condensation pump and receiver offered by this company has a low inlet connection; operates quietly; and the impeller is a bronze centrifugal closed type. Designed for handling hot condensate, the entire unit can be removed for inspection or repair without disturbing piping connections. It is furnished in single or duplex. Bulletin is available. **Item 142**

AXIAL FLOW FANS. Page 52. A line of axial flow fans has been made by this company for industrial air, fume, and vapor handling jobs with volumes from 1700 to 100,000 cfm — static pressure to 3¼ inches—14 sizes, vaneaxial or tubeaxial, direct-connected or V-belt driven, with wheel diameters from 15 to 72 in. Application service is available. **Item 143**

ELECTRONIC AIR FILTERS. Page 54. Electronic precipitators are made by this company for both industry and the home. The filters remove airborne dirt, dust, soot, and pollen. Bulletins on each type of precipitator are available. **Item 144**

AIR CONDITIONING MOTORS. Page 55. Approximately 55 to 60 of this company's motors, ranging in size from 3 to 350 hp, are driving the compressors, condensors, chilled water pumps, and cooling tower fans in a 22-story New York office building. Information about motor applications in air conditioning systems is available. **Item 145**

REFRIGERATION TUBING. Page 56. Copper tubing is made for air conditioning and refrigeration equipment by this fabricator with inside and outside diameters to tolerances within thousandths of an inch. Type L copper tube, soft copper refrigeration tube, and wrought copper solder joint fittings are available from the manufacturer. **Item 146**

Postage Will be paid by Addressee

No Postage Stamp Necessary If Mailed in the U. S.

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 53, SEC. 34.9, P. L. & R., NEW YORK, N. Y.

AIR CONDITIONING, HEATING AND VENTILATING

93 WORTH STREET

NEW YORK 13, N. Y.

AD-DIGEST SERVICE

Ad-Digest

HEAT EXCHANGERS. Page 57. Two of this company's copper-lined storage heaters supply a Dallas hotel with a 10,000-gal supply of hot water for room service 24 hours a day. The company offers a complete line of hot water storage heaters, convertors and instantaneous heaters. Catalogs are available. ..... **Item 147**

ELECTRONIC AIR FILTER. Page 58. The cleaning efficiency of this company's electronic precipitator extends over a range of particle sizes from smoke to large airborne materials. Continuous self-cleaning action keeps collector plates in operating condition, and there is no need for extra sewer or water connections. Bulletin is available. ..... **Item 148**

PIPE-RACKING CHANNELS. Page 60. A line of channels, clamps, hangers, concrete inserts, and rollers is made by this company for the support of steam, gas, heavy water, light conduit or air conditioning lines. The channels require no drilling, welding or riveting, and the framing is completely adjustable. A 78-page catalog is available. ..... **Item 149**

STEEL PIPE. Page 62. The steel pipe offered by this manufacturer has uniform ductility, length, threading, weldability, wall thickness and size, strength and toughness, and roundness and straightness. The length specified is the length received. Information is available. **Item 150**

AIR HANDLING UNITS. Page 63. A vertical air handling unit made by this company provides both product temperature control and comfort air conditioning in the bottling room of a California winery. The units are available in vertical floor-mounted or horizontal ceiling-hung models in capacities from 2.5 to 90 tons. Catalog with specifications is available.... **Item 151**

COPPER WATER TUBE. Page 125. The radiant panel heating system of one church employs 3000 ft. of ½-in. copper water tube made by this company. The tube is suitable for hot and cold water lines, underground service lines, processing lines, drainage and waste lines, and vent stacks. Technical advisory service is available. ..... **Item 152**

CEILING DIFFUSERS. Page 127. The deflection and opposed-blade volume controls of this company's ceiling diffusers are quickly and easily adjustable after installation. The diffusers are available in a wide range of sizes and styles, both recessed and surface types. Information is available. ..... **Item 153**

HEATING-COOLING EQUIPMENT. Page 129. A heating and ventilating system for schools can be made up of three primary parts from this company's equipment. Room units concealed in wall spaces, a central heating and ventilating unit, and finned-pipe radiation along the walls make up the three primary parts of the system. Literature is available. ..... **Item 154**

DUCT FURNACES. Page 131. Sectional duct furnaces are made by this company in sizes from 150,000 to 300,000 Btu per hr, and may be installed in multiple banks. Cabinet blowers are also made by the company in four sizes from 1000 to 8000 cfm. Bulletins with specifications are available. ..... **Item 155**

Circle numbers corresponding to the items and advertisements in which you are interested, print your name and address clearly. Information will be sent directly from manufacturers.

BACKWARD CURVE BLOWERS. Page 133. Backward curve blowers are designed, engineered, and manufactured completely by this company. They are tested according to the test codes. The company is used to producing to customer or government specifications. Bulletins are available. ..... **Item 156**

AIR CONDITIONING UNITS. Page 135. Packaged units for central systems are available from this company in capacities from 3-hp to a plant requiring thousands of tons of refrigeration. Air conditioning estimates are offered. ..... **Item 157**

FINNED TRANSFER SURFACE. Page 137. Increase the turbulence of air flowing over a surface and heat transfer from that surface is increased. This company's finned heat transfer surface is manufactured for the company's air conditioning and refrigeration equipment. Bulletin is available. ..... **Item 158**

DUCT INSULATION. Page 139. Available in compressed rolls up to 72 in. wide in standard thicknesses and lengths, this company's glass fiber duct insulation is cut with an ordinary knife, needs no special measuring, and can be wrapped around ducts and supporting hangers. ... **Item 159**

STEAM SYSTEM CONTROLS. Page 141. A line of steam system controls is available from this company and includes supply valves, room thermostats, motor-operated valves, radiator traps, condensation pumps, commercial radiators, and dirt strainers. Catalogs on each item are available. ..... **Item 160**

FORCED DRAFT BURNERS. Page 143. Each firing unit made by this manufacturer is a complete combustion system consisting of burner, forced draft air supply, fuel system, and control panel. The burner is available for oil, gas, or in a dual fuel combination. Technical information and specifications on forced draft firing systems are available. .... **Item 161**

INTEGRAL-FURNACE BOILERS. Page 145. Integral-furnace boilers are available from this manufacturer in standard sizes for loads to 40,000 lb per hr at steam pressures to 235 psi. Many are in operation at higher pressures and with moderate superheat. Bulletin with detailed description is available. ..... **Item 162**

AIR DIFFUSERS. Page 148. The line of air diffusers offered by this company includes diffusers for cooling, diffusers for cooling and heating, supply and return diffusers, rectangular, square, and half-round diffusers. Adjustable diffusers are available as well as 1, 2, 3, and 4-way diffusers. Catalog is available. ..... **Item 163**

PACKAGED AIR CONDITIONER. Page 149. A packaged air conditioner with oversize cooling coils and a control system which prevents compressor damage is available from this company in five capacities from 3 to 15 tons. The unit is suitable for dining rooms, taverns, drug stores, clothing stores, and offices. Literature is available. ..... **Item 164**

AIR FLOW METER. Page 150. An instantaneous, direct reading, air velocity meter is offered by this company with a wide assortment of jets and fittings for balancing air diffuser installations. Bulletin on the portable air flow meter is available. ..... **Item 165**

HEATING-VENTILATING UNITS. Page 152. New forward curved fans are used by this company in its heating and ventilating units for civic, commercial, and industrial buildings. The company offers a choice of 72 heating coils and 6 coil capacities in both distributing and U-bend coils for each casing size. A 12-page catalog listing details, specifications, and capacities is available. ..... **Item 166**

DUCT NOISE SILENCERS. Page 153. Sound trap units are made by this company to fit any size or shape of duct and to eliminate frequencies in the audio-frequency range to silence entire systems or selected outlets. Four series cover applications from offices to recording studios. Booklet is available..... **Item 167**

INQUIRY CARD

Circle below item numbers on which you wish catalogs or further information.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
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Ad-Digest

SCOTCH BOILERS. Page 155. Scotch boilers are offered by this company for packaged heating units. The area of the boiler directly exposed to the radiant heat of combustion is a greater percentage of the total heating surface. Ratings are moderate but extra loads can be handled with larger burners. Information is available. **Item 168**

COMBINATION AIR DIFFUSERS. Page 155. Air diffusers are offered combined with pendant light fixture adaptations by this company to achieve design simplicity and to assure an uncluttered ceiling. Round, square, and slotted units are available to meet architectural and engineering requirements. Information on each type is available. **Item 169**

GAS-FIRED DUCT FURNANCE. Page 156. A stainless steel, gas-fired, duct furnace is available from this company for use with packaged air conditioners. The furnace is made in five sizes from 88,000 to 213,000 Btu per hr input. A bulletin on the unit is available. **Item 170**

EXPANSION JOINTS. Page 157. Piston-ring expansion joints offered by this manufacturer can be unpacked at full operating pressure. The joints are available in both single and double types in a range of sizes with 4, 7, and 12 in. traverse per slip and for temperatures to 800 deg F and higher. Bulletin is available. **Item 171**

HIGH VELOCITY AIR FILTERS. Page 157. This filter media has special hemmed edges for strength and safe, easy handling. They have a maximum efficency from 288 to 510 fpm. Low velocity and grease filters are also made. Catalogs available. **Item 172**

EXHAUST HOSE. Page 159. The flexible hose made by this company can be used for fume exhaust, for dust or chip collection, for ventilation, or for handling bulky material. Bulletins giving data on flow characteristics, installation procedure, sizes, fittings and accessories are available from the company. **Item 173**

STRIP AIR DIFFUSERS. Page 159. The strip air diffusers made by this company combine the features of both slots and air diffusers to provide equalized air flow throughout the entire length. The slot diffusers can be located in walls, ceilings, coves, moulds, window reveals, and stools. Catalog is available. **Item 174**

LIQUID DEPTH GAGES. Page 160. Remote reading tank gages are available in four models from this company to suit almost every industrial installation. The gages can be installed on tanks above or below the ground and up to one-quarter of a mile away. They can be obtained in multiple units on a single panel and mounting plate. Bulletin is available. **Item 175**

SECTIONAL CONDENSER. Page 161. The casing of this company's condenser is made of sections each separately removable to give access to all parts. The unit removes superheat before condensing and keeps the system purged of oil. Capacity range is from 90 to 240 tons. Bulletin is available. **Item 176**

ROOF VENTILATORS. Page 161. The line of roof ventilators made by this company includes a low contour model, a large volume model for high velocities, wind driven turbine types, and exhaust fans for corrosive fumes. Catalog with specifications and performance data is available. **Item 177**

DUAL PURPOSE CONTROLS. Page 162. Pressure type controls are available in 17 operating ranges from 0-30 in. of vacuum to 300-2500 psi. Temperature types are available in 11 operating ranges from minus 30-60 deg. F to 370-530 deg. All are equipped with external adjustments and visible calibrated dials. Bulletin is available. **Item 178**

SURFACE ANCHORS. Page 162. Surface anchors are manufactured by this company to bond fiber glass, batts, and mineral wool insulations to ducts, walls, and ceilings without drilling, welding or expansion bolts. A technical bulletin with details and specification data is available. **Item 179**

DIRECT DRIVE VENTILATORS. Page 162. Spun aluminum, direct drive ventilators, with rubber mounting, are available from this manufacturer in speeds as low as 490 rpm. Two ventilators are available with capacities from 300 to 9200 and 300 to 2100 cfm. Wall ventilators and belt drive centrifugal ventilators are also available. Catalog is offered. **Item 180**

REFRIGERATION EQUIPMENT. Page 163. A supermarket has this company's refrigeration equipment installed in its meat cutting and storage room, dairy and beverage cooler room, and in its ice cream freezer room. The company's equipment has solved refrigeration problems since 1910. Bulletins are available. **Item 181**

HEAT EXCHANGERS. Page 163. Heat exchangers are manufactured by this company for use as oil coolers, water coolers, or as air or gas coolers for stationary and marine service. The exchangers are designed to minimize thermal change stresses and are built with standard components. Bulletin is available. **Item 182**

SLACK TUBE MANOMETERS. Page 164. A resilient spring steel scale holds the vinyl plastic tube of this company's manometers for easy set-up and use. Standard ranges from 8 to 120 inches of water or mercury are available with plastic $\frac{1}{8}$-in. pipe thread connections. Literature and prices are available. **Item 183**

CONDENSATE PUMPS. Page 165. Condensate pumps are offered by this company for low pressure systems in capacities from 500 to 10,000 sq. ft. EDR. Single and duplex units are available with low return connections, low speeds, cast iron receivers, low water lines, and float switch controls. Bulletin with specifications is available. **Item 184**

OIL UNIT HEATER. Page 165. One of this company's oil-fired unit heaters was installed at an open warehouse platform to enable loaders to work a full day comfortably in any weather. Catalog of oil unit heaters is available. **Item 185**

SPRAY NOZZLES. Page 165. Spray nozzles are engineered and machined by this manufacturer to improve the performance of spraying systems. A 48-page catalog of spray nozzles is available. **Item 186**

MULTI-FUNCTION CEILING. Page 167. A ceiling that provides radiant heating, cooling, ventilation, humidity control, noise reduction, and lighting from one integrated unit is offered by this manufacturer. A booklet containing photographs, details, and design data is offered **Item 187**

AIR CONDITIONING POSITION. Page 167. A career position for an air conditioning engineer is offered by this company in its engineering service division to a graduate engineer with five or more years experience in the selection and operation of heating, air conditioning, ventilating and refrigeration equipment. Interviews may be arranged or resumes sent. **Item 188**

AIR COOLING EQUIPMENT. Page 168. Air-cooled condensers for inside or outside installations and a line of air cooling coils from 2- to 15-ton capacities are available from this manufacturer. Four-row coils are made for residential jobs and 6-row coils for commercial jobs. Engineering service and details are available. **Item 189**

HEAT EXCHANGERS. Page 65. X-rays are taken of the welds of this company's heat exchangers to pick up flaws before they have a chance to become harmful. The X-rays are checked by an insurance company representative to see that each heat exchanger meets or exceeds the standards of the 1952 ASME Code. **Item 190**

AIR CONDITIONING CONTROLS. Back cover. To provide regulation of the air conditioning system, a specially designed system of this company's controls was installed in a new 23-story bank building in the South. All control apparatus is combined into a single system. Temperature control recommendations are offered. **Item 191**

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AD-DIGEST SERVICE

LOUIS BLENDERMANN ON

PIPING AND PLUMBING

Interception of Volatile Liquids

MULTI-STORY garages serve a very definite need since they are the practical solution to the critical parking problems experienced in many of our congested cities.

These unique buildings are used for automobile parking, storage and repair. When erected above ground, such buildings range from one story to ten or more stories in height. When erected underground, the buildings may have from one to six or more levels. In either case, whenever automobiles are stored or parked in a building, they present a potential fire hazard. While fire protection systems will help to extinguish a fire once it has started, it is equally important that means be employed to prevent the outbreak of fire.

Floor Drainage Systems

A well designed floor drainage system is a necessary component of garage buildings. This type system is needed for many reasons, a few of which follow.

1. On wet or snowy days, automobiles, after they are parked in the building, will drip profusely. Floor drains are, therefore, required to receive the drippings and to keep the floor free from water accumulation.
2. The floor of the parking areas is regularly washed down as a cleaning routine. Floor drains are needed for this function.
3. Car washing facilities are often included in the building and also require drainage facilities.
4. In general, a prescribed number of floor drains must be included at each story level for miscellaneous needs as well as to receive the water discharged by the sprinkler system in the event of a fire.

The drainage system to which these floor drains are connected is always an independent system and does not connect to the sanitary system within the building. It does sometimes connect, when required, with the building drain at the building side of the building trap and fresh air inlet. Often, the system will discharge into the outside sanitary or storm sewers or other point of discharge as called for by the local code. This system will become a hazard when volatile liquids are introduced.

Volatile Liquids

A few actual causes are listed to show how volatile liquids enter the drainage systems of garages.

1. Gasoline, kerosene or other volatile solvents normally associated with the cleaning of automobile parts, may carelessly be poured into a floor drain.
2. Discarded oil removed from a car is stored in drums, due to spillage or leakage, this oil will find its way to the floor drain.
3. Gasoline spillage will end up in a drain.
4. Since automobiles drip oil and grease when parked, the drippings will remain on the floor until the floor is cleaned. The oil slick and grease are washed into the drainage system to form a potentional and important fire hazard.

These are situations that permit volatile liquids to enter the drainage system. Such liquids in any form or concentration allow explosive conditions to develop both in the interior and exterior piping systems. Sufficient attention must, therefore, be given to the possible accumulation of the liquids and vapors and methods that can be employed to safely discharge the waste to a point where the combustible liquids can be separated from the waste water.

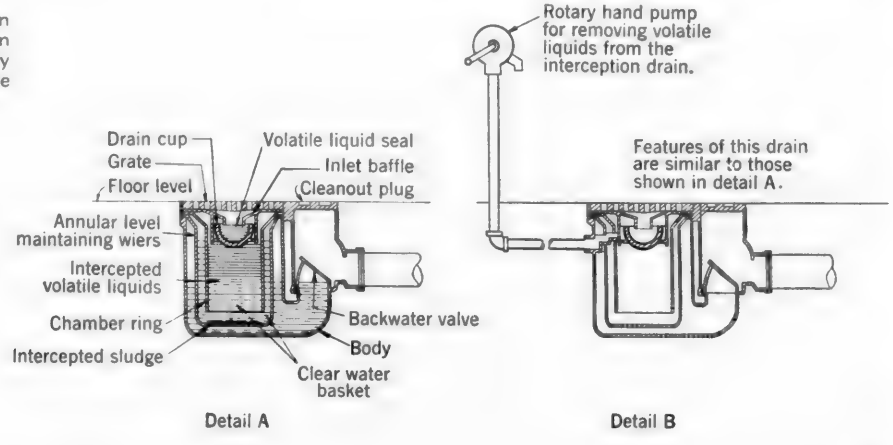


Fig. 1. Recommended individual drain installations to intercept and retain volatile liquids. Detail B has a rotary hand pump for removing volatile liquids.

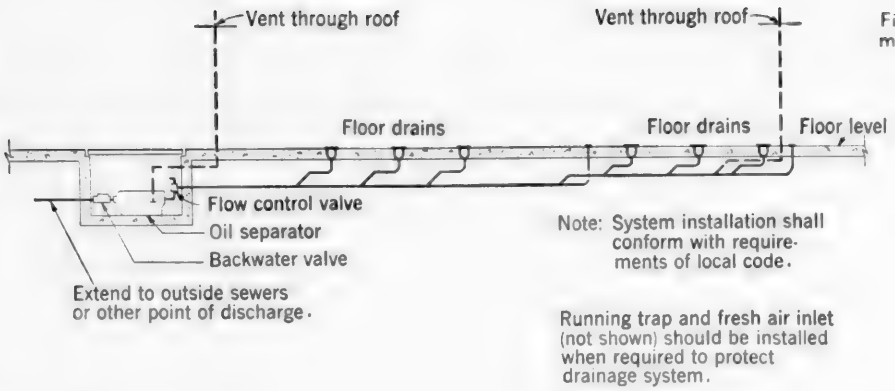

Vent through roof
Vent through roof
Floor drains
Floor drains
Floor level
Flow control valve
Oil separator
Backwater valve
Extend to outside sewers or other point of discharge.
Note: System installation shall conform with requirements of local code.
Running trap and fresh air inlet (not shown) should be installed when required to protect drainage system.

Fig. 2. Typical arrangement of equipment and drains for a one-story installation.

How Fires Start

Vapors liberated from volatile liquids are explosive and can be ignited by a spark provided by static electricity ignition or fire may start from burning cigarettes or matches. Discharge of combustible liquids into a street sewer presents such a potential hazard that a large number of the larger cities require the installation of approved equipment to separate volatile liquids from the waste water.

Individual Drain Installations

There are several methods to separate combustible liquids from waste water. Although this subject is not a new one, greater attention is being focused on it to make this discussion a timely one.

Suitable drains are available for an individual installation, when one or just several drains are required in a specific area. Such drains will intercept and retain the volatile liquids and yet allow the waste water to pass through. A typical drain is illustrated in Fig. 1. Drains illustrated in Fig. 1 serve several purposes. When the waste water is discharged into the drain, the volatile liquids separate and float on the surface of the water. The gas cone prevents the escape of highly explosive vapors while the sediment bucket traps the sand and grit washed into the drain. The waste water will flow unimpeded through the drain.

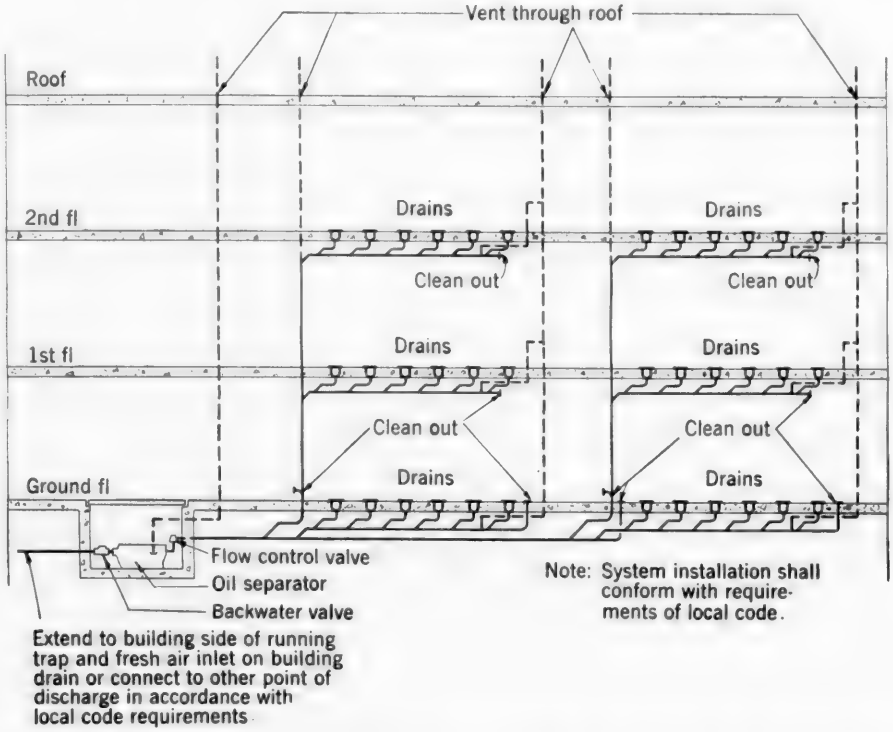
When required, the drain can be equipped with a rotary hand pump for ease in removing the volatile liquids. Such an arrangement is pictured in Detail *B* of Fig. 1.

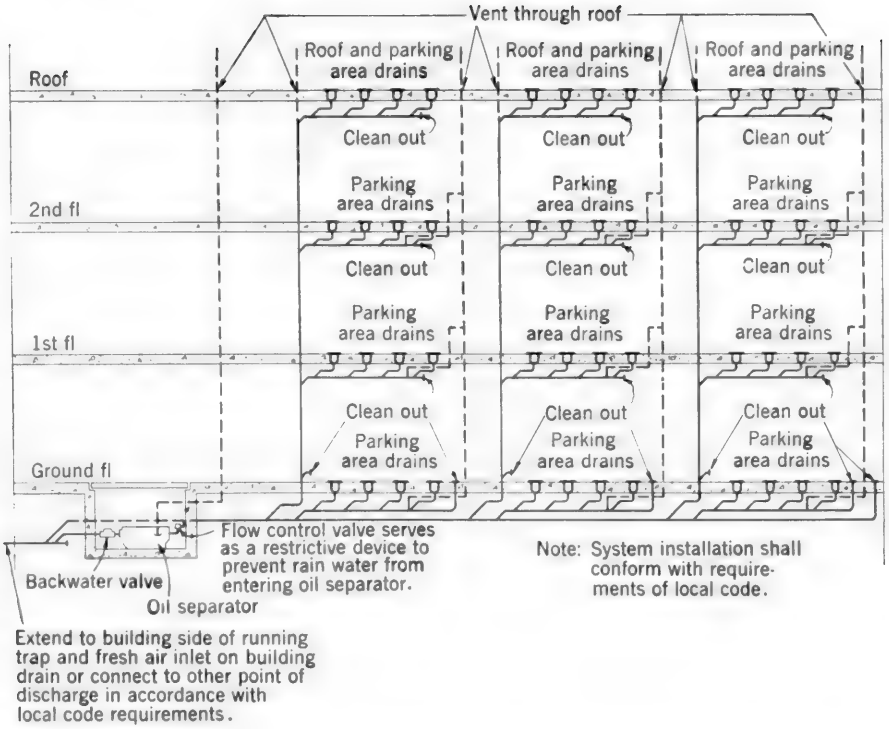
Single Story Installation

When a waste system is required for a single story of a building, a method similar to that shown in Fig. 2 may be employed.

In the installation of Fig. 2, an oil separator is used. Waste water, along with any combustible liquids, is conducted by the drains and piping to the oil separator.

Fig. 3. Oil separator system for a multi-story garage building.




Vent through roof
Roof and parking area drains
Roof and parking area drains
Roof and parking area drains
Roof
Clean out
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Parking area drains
Parking area drains
1st fl
Clean out
Clean out
Clean out
Parking area drains
Parking area drains
Parking area drains
Ground fl
Flow control valve serves as a restrictive device to prevent rain water from entering oil separator.
Note: System installation shall conform with requirements of local code.
Backwater valve
Oil separator
Extend to building side of running trap and fresh air inlet on building drain or connect to other point of discharge in accordance with local code requirements.

Fig. 4. Arrangement of an oil separator system for a multi-story garage building including roof and parking area drains.

Here, the volatile liquids are separated while the waste water passes through. The flow control valve regulates the velocity of the waste water through the unit. Periodic cleaning of the separator is required to remove the accumulation of combustible material from the unit. This can be done by lifting the cover and scooping out such material which floats on the surface of the water in the unit by the hook-up of a rotary hand pump.

This type system represents a safe means of safeguarding the building against the dangers of a fire or explosion.

Multi-story Installations

For buildings that include several floors for automobile parking or storage, a system similar to that shown in Fig. 3 is suggested.

Figure 3 indicates that the drains on the several floor levels are connected to a common waste system. This system of piping terminates at the oil separator system. Here again, the unit separates and retains the volatile liquids while the waste water continues in its passage to the street sewer facilities. The flow control valve regulates the velocity of the flow passing through the separator. Proper venting assures the displacement of accumulated explosive vapors. The separator, in this instance, also requires periodic cleaning for the removal of volatile liquids.

Multi-Story Installations with Roof Parking

For buildings that will include several floors for automobile parking or storage as well as a roof area on which cars are parked or stored, the system becomes a bit more complex. Figure 4 illustrates such an automobile parking arrangement.

The system shown in Fig. 4 is similar to that illustrated in Fig. 3 with the exception that drains have been included on the roof area. These drains serve as parking area drains as well as roof drains.

There are three methods that can be employed to handle the storm and waste water the drains will receive. One method is to install the roof drainage as an independent system and allow the water to run directly to the outside storm sewers.

Another method is to provide the type of a roof drain that actually serves a dual purpose. This drain is equipped with an orifice at the bottom of the drain that permits the normal waste water discharged on the roof to drain into the oil separator system of piping. In addition, the drain is also equipped with an outlet at the side of the drain that will receive the rain water and conduct it to the storm system. When it rains, the restrictive orifice prevents all but a small quantity of water from entering the piping connected to the oil separator system. Thus the rainwater is conducted by the storm water piping to the outside storm water system or other point of discharge.

The final method is a system that utilizes the roof drain for both the waste water and the storm water encountered on the roof. This system is illustrated in Fig. 4. Such a system functions in the following manner.

Waste water, a result of washing the roof will flow into the drain to be conducted by the piping system to the point of the oil separator. Here because of the small quantity of water involved and the low velocity of its flow rate, the water will drain into the vertical pipe connection to the oil separator. It will pass through the flow control valve into the separator where the volatile liquids are separated and retained. The water itself will pass through the separator and out to the point of discharge.

However, when it rains, the water will flow into the same drain and system of piping to the point of the oil separator. The restrictive action of the flow control valve

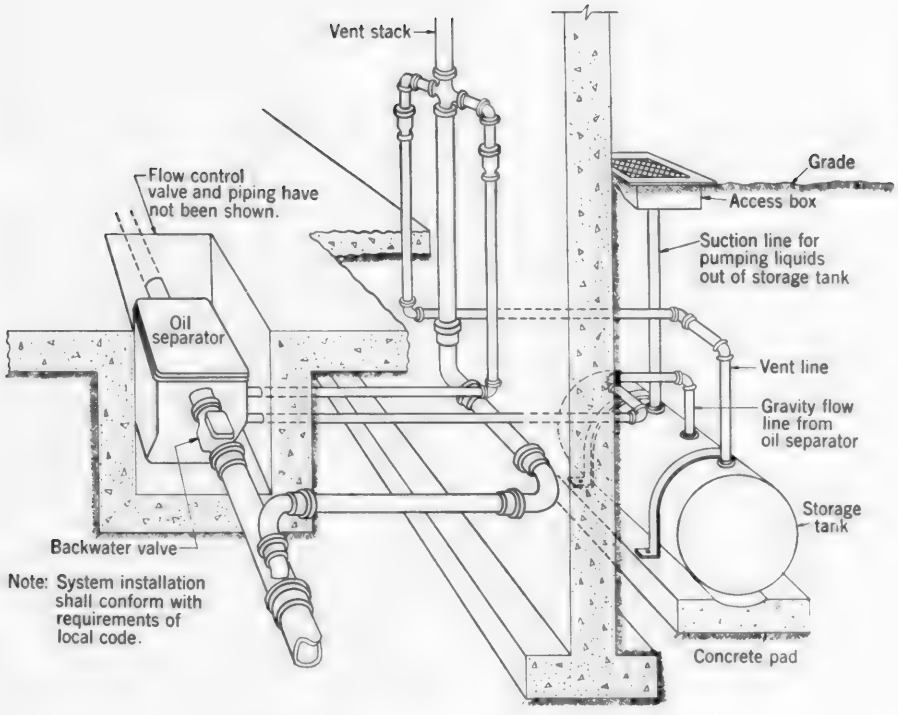

Vent stack
Flow control valve and piping have not been shown.
Grade
Access box
Suction line for pumping liquids out of storage tank
Oil separator
Vent line
Gravity flow line from oil separator
Storage tank
Backwater valve
Note: System installation shall conform with requirements of local code.
Concrete pad

Fig. 5. Typical arrangement of oil storage tank, oil separator and component piping. When required, the vent lines should be extended up through roof and terminate as separate vent lines.

will permit only a very small amount of water to pass into the oil separator. The rain water by virtue of its quantity and rate of flow will bypass the oil separator and will discharge directly into the street sewer. Since water will follow the path of least resistance, the bypass action is possible.

The backwater valve located at the discharge side of the oil separator prevents sewage backflow from entering the oil separator.

Storing Volatile Liquids

For systems that will experience large concentrations of volatile liquids, sufficient thought must be given to a proper means for receiving and storing the liquids. For this condition, a storage tank is usually employed and Fig. 5 shows a typical installation.

In Fig. 5, the storage tank is located outside the building. Its size and capacity are determined by the engineer for the particular requirements of the system. The tank must meet the requirements of the National Board of Fire Underwriters as well as the Code for Unfired Pressure Vessels and it is placed on a concrete slab or mat and securely anchored in place. A suction line, that is also used for testing the capacity of the storage tank, is extended to grade with proper provisions as shown.

The draw-off line from the oil separator is connected to the tank. An adjustable line in the separator is set at an elevation just above the water level and permits the volatile liquids to run into the storage tank by gravity. Adequate venting must be provided to remove any accumulation of explosive vapors. When desired, two vents may be connected to the separator to ensure a more positive circulation of air. If two vents are installed, one vent should be connected to the vent stack at a higher elevation than the other to induce circulation by an unbalanced air pressure.

Systems illustrated in this article represent a concept in the handling of the combustible liquids which is a definite phase of plumbing design. This subject is a broad one and extends to many other types of buildings including aircraft hangers where volatile liquids are stored, handled or encountered.

Fresh Water from the Sea at Low Cost

Fresh, pure water from sea water at the cost of 33 cents for 1,000 gal is now possible with the new Cleaver-Brooks waste heat evaporator. Utilizing the waste heat from the ship's diesel engines, the new evaporator in effect raises diesel efficiency from 30 to 60% in producing an abundant source of pure water that is suitable for shipboard uses.

While there are many applications for this unit, one use is on offshore drilling rigs where fresh water is essential for drilling mud makeup, drinking and bathing. Water for such applications is now barged in at a cost as high as 25 cents a barrel.

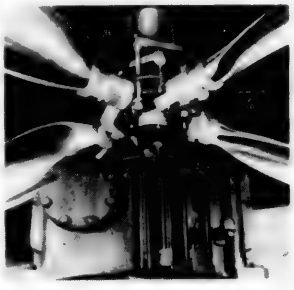
A waste heat evaporator can save as much as $161.70 a day over barging in water at 25 cents a barrel. The waste heat evaporator makes use of normally wasted heat dissipated in jacket heat, lube oil and diesel exhaust. It produces an abundant source of fresh water in direct proportion to waste heat available. Characteristic curves show that at less than 80,000 Btu per minute, the four-stage evaporator will produce 1500 gph of distillate.

NEWS OF EQUIPMENT AND MATERIALS

Use the convenient prepaid postcard appearing on page 105 for securing additional information on new equipment and materials described in this department.

Variable Pitch Fan

A controllable pitch, heat exchanger fan has been designed by Hartzell Propeller Fan Co., Piqua, Ohio, for maintaining predetermined fluid outlet temperatures.



Variable air delivery is accomplished by the variation in blade pitch setting. The fan assembly responds automatically to conventional control equipment, increasing blade pitch to deliver more air when the outlet temperature rises, decreasing blade pitch and delivering less air when the outlet temperature falls.

The design of the controllable pitch fan is based on the same principle used on the company's propellers for light twin-engine airplanes. In fact, many of the same parts are used. The ball-bearing and clamp blade retention mechanism is one. Another is the heavy torque tube which withstands torque and bending loads. The pitch change mechanism is adaptable to precision control.

Complete details are supplied in Bulletin A-113, which is available from the company.

More information? Circle Item 1 on postcard, page 105.

Manual Fastening Tool

A manually-powered fastening tool is announced by Ramset Fastening System, Olin Mathieson Chemical Corp., Cleveland, Ohio.

Named Shure-Set, the tool operates on the same principle that permits a needle to be driven through a coin if it first goes through a cork. It is the support of the pin by the cork which makes this phenomenon possible. The support given to the fastener by the tool enables the fastener to utilize a maximum amount of the driving force transmitted to the fastener by a hammer.

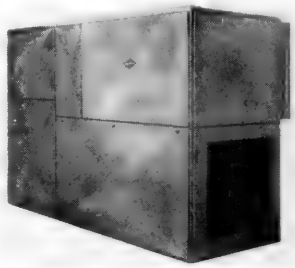
The tool can seat a fastener into a variety of materials such as concrete, concrete block, cinder block, brick, and steel. It is designed to fill the need for a device for light fastening work which cannot be done by simple techniques, such as a hammer and ordinary nail, but which does not require the large driving force of a powder-actuated fastening tool.

The tool accommodates 1/16- and ¼-in. fasteners.

More information? Circle Item 2 on postcard, page 105.

Package Air Conditioners

Two improved packaged air conditioners, ranging in size from 7½ to 60 hp, are being marketed by Union Asbestos & Rubber Co., Heating and Cooling Div., Chicago, Ill.



Known as the AECR and the SCR, the units are designed for stores, large offices and industrial installations. The AECR is equipped with an evaporative condenser, while the SCR utilizes a water-cooled condenser. Either unit can be equipped with three types of heating coils as optional accessories: steam, non-freeze, or hot water.

The AECR is available in 7½, 10, 15, 22½, 30, 40, 50, or 60 hp capacities. The 10- through 30-hp and the 60-hp AECR units have multiple compressors and multi-refrigeration circuits, one for each compressor, which permit control of both temperature and humidity. Under light load conditions only one system is operating but as the cooling load increases, the remaining systems cut in automatically.

The standard AECR unit has a four-row cooling coil but can be equipped with a six-row coil for high latent load requirements.

The SCR unit, equipped with the water-cooled condenser, may use either a direct water supply or a water tower. It is available in the same capacity range and multiple circuit arrangements as the AECR model.

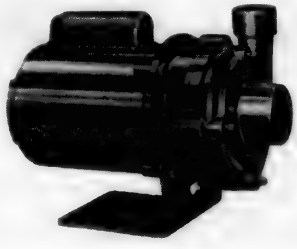
More information? Circle Item 3 on postcard, page 105.

Centrifugal Pumps

A series (No. 170) of centrifugal pumps is announced by Taco Heaters, Inc., Cranston, R. I.

Two sizes (⅓- and ½-hp models) are presently available with larger sizes to be made available shortly.

Unless otherwise specified, motors furnished are 3450-rpm, 60-cycle, single phase standard jet type with overload protection and permanently sealed ball bearings. Three phase motors are available that require starting switches with overload protection. The mechanical seals used (2-piece type) are self-adjusting, self-lubricating, and replaceable. No lubrication is required as all parts are permanently or self-lubricated.



Mounting flexibility is provided by a volute designed for a choice of four discharge positions and a heavy stamped steel base which permits slightly out-of-line pump connections without causing noisy performance.

More information? Circle Item 4 on postcard, page 105.

Bags Collect Dust

Cyclone-type dust collectors will be furnished with after-filter bags made of Dacron cloth, in place of the standard wool, by Torit Mfg. Co., St. Paul, Minn.

Tests by the company's engineers showed that the Dacron cloth is as effective a filter medium as wool and will not burn when exposed to a continuous shower of sparks. In addition, the material will not shrink when laundered or be attacked by moths or mildew.

Five collector models are affected by the change: Models 12FB, 13FB, 18FB, 19FB (illustrated), and 219FB. Prices will remain the same, despite the change of material, and bags are available for machines already in operation.

By using the after-filter bags, one can recirculate clean, heated air indoors, where regulations permit, instead of exhausting it out of doors, thereby reducing heating costs.

More information? Circle Item 5 on postcard, page 105.

Grille for Large Windows

A grille, Uni-Flo Model ST, designed for continuous line installation under large windows, is available from Barber-Colman Co., Rockford, Ill.

The grille is designed to prevent the cold convection currents which often occur near large window areas. It is suitable for heating, ventilating, and air conditioning school rooms, hospitals, and other buildings where large glass areas are used. Several finishes are available.

A recently completed catalog (F-7757) includes descriptive information along with performance data for the grille.

More information? Circle Item 6 on postcard, page 105.

Pressure-Sensitive Tape

A pressure-sensitive tape that resists the action of many reactive chemicals and drastic temperature changes is announced by Minnesota Mining and Mfg. Co., St. Paul, Minn.

Carrying the Scotch brand name and designated No. 549, the tape combines the properties of a Teflon film with the chemical and heat resistant properties of a pressure-sensitive adhesive.

Semi-transparent and colored blue-gray, the tape is designed for application to a variety of surfaces. A cover on the jaws of heat sealing equipment, for example, gives quick releasing properties and offers chemical protection to the sealing jaw surface. It is expected to help prevent corrosion by protecting exposed surfaces, while its sliding property should make it of value to the food industry for use on food processing equipment.

Made in both a 3½- and 6½-mil thicknesses, the tape consists of 2- and 5-mil films coated with 1½-mils of silicone adhesive. The 3½-mil tape has a 200% elongation and a tensile strength of 25 psi of tape width, while the 6½-mil tape offers 150% stretch and 40 psi tensile strength.

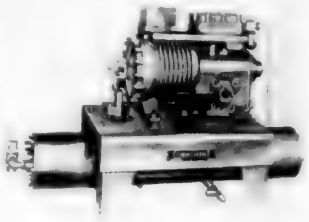
Both tapes are unaffected by temperature change within the range of −65 to 400 deg F continuously (457 deg intermittently).

The tape is being made available nationally in ¼- to 5-in. widths on 36-yard rolls. Technical details are given in Bulletin No. 15.

More information? Circle Item 7 on postcard, page 105.

10-Hp Condensing Unit

A 10-hp, Copelametic condensing unit for air conditioning and other high suction pressure applications has been developed by Copeland Refrigeration Corp., Sidney, Ohio



Heart of the unit is a refrigerant-cooled, 10-hp motor-compressor. The condenser is a water-cooled shell and tube type, and its design permits either packaged or remote installation.

Fully assembled, the unit measures 31⅜ in. high, 20 in. deep, and 53 in. long, including the condenser water inlet connection. The condenser-receiver can be hooked up in a cooling tower installation.

The three-cylinder motor-compressor has a 2 3/16-in bore, 2-in. stroke with a refrigerant capacity of 1375 cfh at 1750 rpm.

More information? Circle Item 8 on postcard, page 105.

Tool Cuts Brittle Pipe

A 4-wheel, hinged cutter, designed for Duriron acid resisting pipe, is offered by Reed Mfg. Co., Erie, Pa.

Available in five capacities to cover the range from 1½ to 12 in. pipe, the cutter can make right-angle cuts as close as 1½ in. to the end without cracking the brittle pipe. With sufficient speed, 4-in. diameters of the high silicon iron pipe can be cut in less than one minute.

Using the same basic design as the company's hinged cutter for conventional steel and cast iron pipe. The new tool has nickel-chrome alloy cutting wheels. It maintains a uniform cutting force even when the pipe is out-of-round or when raised numbers or letters are encountered on the outside of the pipe.

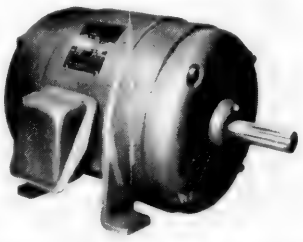
The hinged frame and 4-wheel design simplifies close-quarter cutting of pipe in the line since the tool operates with slightly more than a quarter-circle swing of the handle.

Additional details are given in Bulletin HD.-3.

More information? Circle Item 9 on postcard, page 105.

Plastic Insulated Motors

A line of motors, called Linc-Weld, with extruded plastic insulation is introduced by The Lincoln Electric Co., Cleveland, Ohio.



Available in standard sizes from 1 to 40 hp, the motors are built in the open type frame and torque design B. They comply with NEMA specifications.

The thermo-setting plastic insulation, unlike insulation applied by dipping, is molded into and around the stator windings. The motor stator is placed into a die and the plastic material is forced into the die under the proper heat and pressure. The liquid plastic resin is extruded through the stator slots, completely covering the stator winding. After the plastic resin sets, the stator is removed from the die. The result is a motor winding that is encased in plastic insulation.

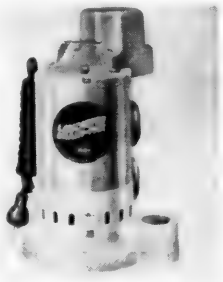
In addition to chemical protection, the insulation provides thermal protection. The plastic provides a medium for conducting the heat uniformly away from the wire. It also provides a degree of physical protection for it anchors the windings completely and permanently to the stator frame.

Even though the motor is built in the open type frame, the company states that it may be used as a splash-proof motor. It may also be used as a totally enclosed motor in many applications.

More information? Circle Item 10 on postcard, page 105.

Submersible Pump

A submersible pump for use wherever a totally submerged sump pump is required is offered by the Lancaster Pump and Mfg. Co., Inc., Lancaster, Pa.



Two models of the pump, called Drain-Pak, are offered. One is made entirely of bronze, and the other is made of cadmium plated, cast iron. The pump is equipped with a ⅓-hp, 60-cycle, 110-v motor with automatic overload protection. An 11-ft rubber covered power cord is supplied with the pump.

Catalog literature with the specifications of the pump is published by the manufacturer.

More information? Circle Item 11 on postcard, page 105.

Alloys For Liquid Heaters

Platecoils are now available in several special alloys to extend their application in corrosive, highly acid, and other specialized industrial processes, according to Tranter Mfg., Inc., Platecoil Div., Lansing, Mich.

The platecoils are designed to replace pipe coils in industrial processes requiring the application or removal of heat. They consist of two embossed metal sheets welded together to provide a preformed channel for the flow of heating or cooling media.

Alloys available, and their recommended applications, include:

Type 316 stainless steel, for phosphate coating, electroplating, nitric acid, food processing, fruit juice treatment, most petroleum and vegetable oil processing, starch and sugar solutions, paints and varnishes, and for cooling sulfuric acid in anodizing applications.

Monel, recommended for water applications of all types, including salt water. It has a negligible corrosion rate in neutral and alkaline salts, is resistant to refrigerating brines, and to acid-salt solutions. It is also recommended for heating zinc ammonium chloride.

Carpenter 20, to provide maximum corrosion resistance to sulfuric acid solutions not contaminated by chlorides or bromides.

Hastelloy B, for use in hydrochloric acid, up to the boiling point, and Hastelloy C, considered the most universally corrosion-resistant alloy available today.

Commercially pure A nickel which is almost completely resistant to corrosion by alkalis, including caustic soda.

More information? Circle Item 12 on postcard, page 105.

Cast Iron Baseboards

Increased heating capacity and modern styling are features of the cast iron baseboard panels for forced hot water or steam announced by Plumbing and Heating Div., American Radiator & Standard Sanitary Corp., Pittsburgh, Pa.

Named Radiantrim, the baseboard panels are designed to provide both radiant and convected heat. They are available in 24-, 18-, and 12-in. sections which permit installation in 6-in. increments.

Apertures along the top of the panels direct heat into the room. Fins are spaced 42 per 24-in. section in the back of the panel and are tapered so that they are not seen through the apertures. Their design and arrangement give a heating surface of over 6 sq ft for every 24-in. section.

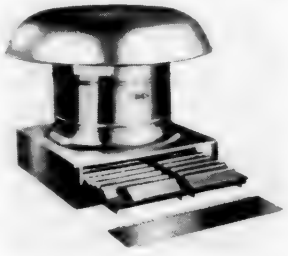
Valve enclosures, end boxes, and finishing panels are installed on the mounting bracket with concealed clips. There are no screws located on the outside of the enclosure. The assembly clamp facilitates joining panel sections and aligning the assembly. The clamp helps to guard against breakage, cocked nipples, and other assembly difficulties.

The panels are high enough above the floor to permit cleaning underneath. Following their installation, quarter round or wood moulding strips can be added to the top of the panel assembly to give a neat, tailored finish. The panels can be painted with any non-metallic, heat-resisting paint to harmonize with surrounding walls or furnishings.

More information? Circle Item 13 on postcard, page 105.

Power Roof Ventilator

A roof ventilator for use on commercial industrial and public buildings is available from Ilg Electric Ventilating Co., Chicago, Ill., in five sizes with low and high speed models to meet a variety of requirements.



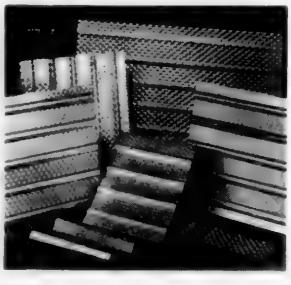
Called Type LSQ, the power roof ventilator is shipped completely assembled and enclosed in its aluminum housing, which does not require painting. The unit's propeller fan is connected directly to a permanent, split-capacitor motor. All electrical connections are in the mounting saddle on the outside of the housing, and the motor has sealed, permanently lubricated, ball bearings. The fan wheel is statically and dynamically balanced.

Shutters of gravity and motor-operated types with interconnected blades to eliminate back draft are available as accessories. They are mounted in the base of the unit where they are accessible.

More information? Circle Item 14 on postcard, page 105.

Embossed Heat Exchangers

Tube-In-Strip is one of the newest products to take on additional benefits by the embossing process called Rigidizing of Rigidized Metal Corp., Buffalo, N. Y. Tube-In-Strip is a single sheet of solid copper, brass, or aluminum in which tubes are inflated in running lengths in a variety of shapes and sizes.



By embossing the flat sheets or strips before inflating, any of more than forty standard patterns, named Rigid-Tex, can be produced. The strips are then inflated by the application of air or hydraulic pressure to form the tubes. Since the strips find their greatest use in heat exchange applications, embossing increases the heat transmission efficiency of the metal in direct proportion to the increased surface area obtained by the process. Several patterns have been designed for maximum heat transfer. These are the deeper patterns shown in the group illustration.

Embossing increases rigidity and buckling strength, and produces greater tensile strength than the original flat metal. This increased stiffness and strength makes possible the use of a lighter metal to meet the physical requirements of flat metal.

Some of the sample patterns shown in the illustration (the shallow patterns) add less strength to the flat metal but are decorative, achieving various effects in texture. Scratches, fingerprints, smudges and dents are concealed by the texture.

As shown, the area between the tubes can be perforated for air circulation either natural or forced. This might suggest a method of baseboard heating combining hot water or steam with forced air. Another suggested application for perforated strips might take advantage of the acoustical properties of perforated metal when backed by felt, glass, fiber or similar sound absorbing materials. It could then be used on a ceiling with cold water circulated through the tubes for room or office air conditioning.

More information? Circle Item 15 on postcard, page 105.

Small Steam Trap

A steam trap is available in a $\frac{3}{8}$-in. size from Sarco Co., Inc., New York, N. Y., as well as in $\frac{1}{2}$, $\frac{3}{4}$, and 1-in. sizes.

Slightly larger than a fifty-cent coin, the $\frac{3}{8}$-in. size trap is suitable for applications such as tracer lines. It operates against back pressures up to 50% of the inlet pressures and closes on no load. The trap can be used on lines carrying pressures from 10 to 600 psi.

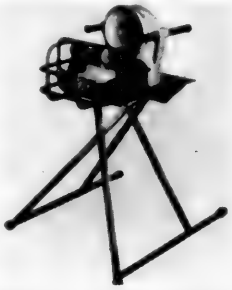
Called TD thermodynamic, the trap has only one operating part, a solid hardened stainless steel disc. The other two parts, the cap and body, are also made of stainless steel.

Bulletin 257B describes the operating principle of the trap.

More information? Circle Item 16 on postcard, page 105.

Pipe Cutter Drive

A portable power drive for cutting, reaming and threading pipe is available from Oster Mfg. Co., Cleveland, Ohio. Because it weighs 80 lb, the machine is called the No. 142 Featherweight Champ by the company. The unit permits one-man operation; converts regular hand die-stocks, cutters and reamers to power tools; and turns up fittings and takes them off as well.



To fit the needs of users, the machine is available in models equipped with gasoline, electric, or pneumatic drives. All three are interchangeable. The gasoline unit is equipped with a Mercury clutch, made by Automatic Steel Products, Inc., in Canton, Ohio, which allows the power source to reach full operating speed before the load is engaged, then applies the power automatically. After the load is accelerated, power is transmitted at 100% efficiency.

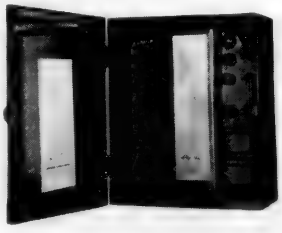
With an aluminum alloy frame and folding tripod, the machine can be carried by one man. It is designed to handle pipe from $\frac{1}{8}$ to 2 in. in diameter.

For longer service life, the driving gears are made of hardened steel, and all gears and shafts are ball bearing mounted for quieter operation. A handwheel operates the jaws of the unit's chuck.

More information? Circle Item 17 on postcard, page 105.

Electronic Burner Controls

Two flame-safeguard relays, featuring electronic flame detection, a choice of control sequences and timings, and a safe-start component check, have been developed by Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.



Trade-named Protorelays, the units (Models R478A and R478B, are made for oil, gas, and dual-fuel burner control. Model R478A uses two-flame rectification, detection circuits for use with either flame rod or standard photocell, or both. The R478B features a lead sulphide photocell sensing unit for both gas and oil flames. It also uses a separate flame rectification circuit for proving the pilot with a flame rod.

In addition to the standard safe-start interlock following every burner shutdown, the relays also incorporate the firm's safe-start component check system to double-check the electronic circuitry after every power failure. The check, made when power is restored, is designed so that each step must be proved before the sequence can continue.

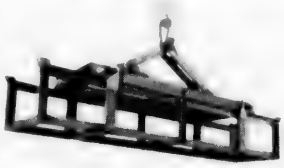
Models of the relays are available with 5- or 30-second, pre-purge timing, 15, 60, or 180-second ignition timing, interrupted or intermittent pilot, and high-firing as the main fuel valve opens or at the end of the ignition timing period. A choice of one sequence for oil firing and another for gas can be obtained through the use of an external fuel transfer switch. Models are available for 120, 208 and 240-v—60 or 50 cycle—applications.

Both relays use the same panel or cabinet. Wiring changes are limited to the difference between lead sulphide cell wiring and flame rod, photocell wiring. Both feature quick disconnect mounting with terminal facilities arranged in the cabinet so that the relay can be wired before the chassis is installed.

More information? Circle Item 18 on postcard, page 105.

Racks Store Pipe

Portable, heavy duty, bar racks are being manufactured by Palmer-Shile Co., Detroit, Mich., for handling and storing piping and tubing.



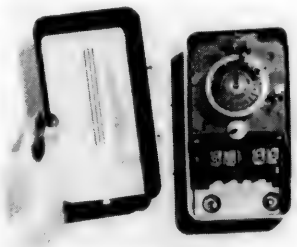
The racks are designed to prevent damage to stock in tiering and storing. They have a flush bottom and top. An extra thickness of lift bar is welded to the racks for additional strength and safety.

Piping and tubing may be stored in multiple tiers, to any height, by using automatic tongs suspended from an overhead crane (as illustrated). The racks are built to specifications to handle piping and tubing of any length and load capacity.

More information? Circle Item 19 on postcard, page 105.

Time Switch

A general-purpose time switch is announced by General Electric Co., Schenectady, N. Y.



Suitable for indoor and outdoor use, the switch is designated TSA-40, replacing the T-27. It will turn electric circuits on or off at any time of day to control heating, air-conditioning and refrigeration equipment, irrigation and pump devices, and other types of apparatus where time control is necessary.

The switch is furnished with either a plain dial for fixed time setting or an astronomic dial for dusk and dawn schedules. It may be set to any time of the day with the minute-set dial and maintains a time schedule with the accuracy of an electric clock. One or more days may be skipped during a week of operation with the use of an omitting device.

Operating voltages of the control are 120, 240, and 480v a-c. The frequencies are 60, 50, and 25 cycles. The timer weighs 4¾ lb, net, and its dimensions are 9 19/32 x 6 5/32 x 4 11/32 in.

More information? Circle Item 20 on postcard, page 105.

Gas Detectors Are Portable

A line of portable instruments for detecting and measuring flammable gases and vapors is being produced by Mine Safety Appliances Co., Pittsburgh, Pa.

Four models, each intended for specific functions, are included in the line of combustible gas indicators. All models are the same size (5 x 4 x 6 in.) and use standard detector and compensator filament units which are obtainable from the company's warehouse stocks throughout the country. A spare set of the replaceable filaments is mounted within each instrument.

One of the principal features of the new instrument is its compactness. It weighs 6 lb, in contrast with the 12-lb weight of earlier models. Power to operate the instrument is supplied by eight dry cell, flashlight batteries.

Most instruments are individually calibrated at the factory for the particular types of gases and vapors for which they will be used. Samples of atmosphere to be analyzed are drawn into the instrument by squeezing an aspirator bulb. The atmosphere is tested for combustibility by a balanced Wheatstone Bridge circuit, supplied with current by the batteries. Batteries provide 10 to 11 hours of continuous service.

The line of combustible gas indicators is described in Bulletin No. 0804-2, published by the company.

More information? Circle Item 21 on postcard, page 105.

Drinking Water Cooler

A drinking water cooler, manufactured by Sunroc Corp., Glen Riddle, Pa., is available in a range of capacities from 6 to 42 gph for small to large requirements of restaurants, schools, institutions, and commercial and industrial cafeterias.

Equipped with a coil cooling system, all models, including the 42 gph, are 36 in. high, 28 1/16 in. wide, and 21 3/16 in. deep. The cooling unit has seamless copper tubes that cool the water that flows through them.

Available for either wall or island location, the unit is supplied with a cabinet in either a stainless steel or grey hammertone enamel finish. The stainless steel top and drain grill is equipped with glass fillers, bubblers, or a combination of each to meet individual requirements. Double-headed glass fillers are available for island locations to make the unit accessible from all four sides. All fixtures are plated with polished chrome.

Stainless steel top and side shelves are supplied on special order, and the cabinet accommodates up to two side shelves on either or both sides. The shelves are designed to provide up to 15 sq ft of storage space for glasses and trays.

More information? Circle Item 22 on postcard, page 105.

Fly Ash Collector

A fly ash collector and an induced draft fan are offered in a single unit by Breslove Separator Co., Pittsburgh, Pa. The collector section removes fly ash, soot, and cinders from stack gases, and the fan section provides draft for boiler operation.

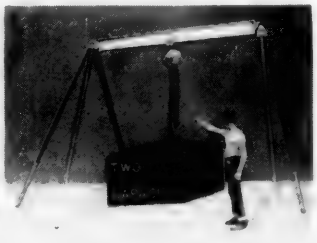
The units can be used for new boilers to provide all the draft required, or they can be used with existing boilers that require dust collection and increased draft to improve performance or to handle greater loads.

The combination units are available in a range of capacities and in a number of different physical arrangements to fit different space conditions.

More information? Circle Item 23 on postcard, page 105.

Portable Gantry

A portable gantry, using a high strength, aluminum alloy I-Beam, is announced by B. E. Wallace Products Co., Exton, Pa.



A feature of the unit is the tripod end supports which can be used independently at any time.

Leg length is adjustable by as much as 7 ft in order to facilitate storage, moving, and erection. Setups can be made where overhead is low, or where another job may require high clearance. One end can be mounted on a truck bed or platform, if necessary.

The gantries are available in heights up to 17 ft and with I-beams as long as 20 ft. The maximum capacity is 2 tons. Accessories are available to interconnect the tripod legs where required. Other accessories provide rubber pads for use on polished floors.

More information? Circle Item 24 on postcard, page 105.

Cooling Pump Mufflers

A line of mufflers for use in reducing pumping noise in refrigeration or air conditioning systems is introduced by Heat-X, Inc., Brewster, N. Y.

Installed on the discharge line of a refrigeration compressor, the units damp pulsations and vibrations in the lines. They may be mounted in a horizontal run or in a vertical run with the flow downward.

Built to ASME specifications the mufflers feature seamless pipe and welded steel construction. The expansion chambers and baffles are arranged to obtain a maximum efficiency and a minimum pressure drop. They require no maintenance.

Models are available with lengths from 20 to 48 in., outer diameters from $6\frac{5}{8}$ to $10\frac{3}{4}$ in., with IPS connections from $\frac{3}{4}$ to 4 in.

More information? Circle Item 25 on postcard, page 105.

Wet Dust Collector

A wet dust collecter named Ventrijet is manufactured by Pangborn Corp., Hagerstown, Md. The unit atomizes water and mixes it with an air stream to transfer dust by the movement of air without mechanical means.

Dust laden air enters the collector and expands in the inlet chamber at reduced velocity. The heavier particles sink to the bottom of the tank as sludge. The air is drawn through one or more venturi tubes into the discharge chamber, and the low pressure area in the venturi throat induces water to enter the high velocity air stream.

The mixing of air and water causes the transfer of dust particles from the air to the water particles, forming a sludge. The air, water, and sludge mixture then impinges, at a high velocity, on special surfaces in the discharge chamber, sending the sludge to the tank bottom. The washed air then flows through an eliminator section for the removal of droplets and is discharged.

The dust collector is available in a range of capacities from approximately 1,000 to 30,000 cfm with single or double rows of venturi tubes.

More information? Circle Item 26 on postcard, page 105.

Immersion Heater

A combined immersion heater and thermostat, prewired and ready to be connected into an available circuit, is introduced by N. J. Thermex Co., Inc., Harrison, N. J.

Designated ThermX QT, the heater is suitable for use in both small plating tanks and in an independent series in large tank installations. In large tanks, individual portable units do not require relay switches. Worn elements can be replaced in a matter of 5 to 10 minutes.

Fused quartz sheathes the sensing bulb, providing insulation against stray electrical currents and resistance to most corrosive acids. For cyanides and caustic solutions, the Model SST heater and thermostat combination is made of stainless steel. In applications where rough usage may damage the Model QT heater sheath, the company supplies chemical-resistant, perforated protective tubing as additional equipment.

The maximum heating capacity of the unit is 6000 watts. It is equipped with a dial control which may be set for a standard temperature within the desired operating range (from 50 to 250 deg F). Other ranges can be supplied upon request. The sensing bulb length is 12 in., the capillary tubing is 36 in. long. Variations from standard specifications are also provided by the company on the heater section of the unit.

More information? Circle Item 27 on postcard, page 105.

Drinking Water Cooler

A pressure type water cooler is announced by Cordley & Hayes, New York, N. Y.

Measuring 1 ft square and 3 ft high, the unit can cool 2.9 gph of 80-deg F water to 50 deg at room temperature of 90 deg. This is considered enough chilled water to meet the normal hourly needs of more than 85 office workers.

Designated the M3S, the cooler does not require a drain connection. It is connected to the cold water supply line and plugged into the nearest electrical outlet. A 1½-quart capacity receptacle is provided for waste.

The cooler has a chrome plated brass, push button type faucet with an automatic pressure regulator that provides a uniform flow of water with variable outside supply pressures. A stainless steel, louvered, drip tray prevents splashing. Provisions are made on both side panels for attaching paper cup dispensers.

Water temperature is regulated with a thermostatic control that has a 10-deg adjustment range. The control is reached through an opening provided for the waste receptor.

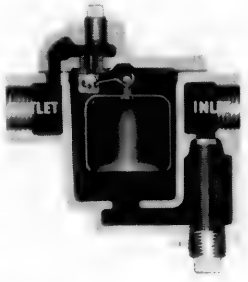
The refrigeration system uses a hermetically sealed, 1/6-hp compressor. Its vertical, static type, air-cooled condenser is accessible for cleaning. The 5-oz charge of Freon-12 is capillary controlled. The entire refrigeration system is guaranteed for five years.

Finished in hammerloid gray with a black recessed base, the cooler will operate on a 50- or 60-cycle, 115-v line. A plug-in transformer is available for operation on 230-v. The complete unit weighs 72 lb.

More information? Circle Item 28 on postcard, page 105.

Combination Strainer Traps

A line of steam traps with built-in strainers has been developed by The Clark Mfg. Co., Cleveland, Ohio.



A part of the company's Thriftrap line, the new strainer traps are made of cast semi-steel and are equipped with either standard or double-step leverage. The seats and discs are made of Clark-Loy, a heat-treated stainless steel that resists corrosion, wire drawing, or cutting. The traps are designed for pressures up to 250 psi and temperatures to 450 deg F. They have horizontal inlet and outlet connections.

Complete specifications of the strainer traps are published by the manufacturer.

More information? Circle Item 29 on postcard, page 105.

Waterproofing Material

A waterproofing material that sets in five minutes or less and bonds to concrete or other masonry walls or floors is offered by Maintenance Engineering Co., Philadelphia, Pa.

Called Meco Sealtite, the material seals masonry walls against hydrostatic pressure. Because of its setting and bonding qualities the use of forms and other braces can usually be eliminated.

Generally, the application below grade is made by sealing the cracks with the mortar produced, or by plaster-coating walls that are or can be made free of hydrostatic pressure at the time of application. To waterproof blocks above grade, application is generally made by a brush except in cases where holes or mortar joints need filling.

The material is used to stop or prevent leaks in dams, basements, elevator pits, tunnels, and mine shafts and is used to waterproof reservoirs, wells, tanks, aqueducts and other similar structures. It also makes concrete resistant to oil, grease and acid. It is supplied in liquid form and mixed with Portland cement for severe conditions or with Portland cement and sand for ordinary conditions.

More information? Circle Item 30 on postcard, page 105.

Line of Valves

A line of flow control valves called Quick-Dump, has been placed in production by Humphrey Products, a subsidiary of General Gas Light Co., Kalamazoo, Mich. The valves are intended for use in original equipment, as well as applications in industry that require either manual or automatic valving of air, water, oil, or Freon.

The line utilizes a single basic valve body which may be used either normally open or normally closed, depending upon port connections. To this standardized valve body may be added a variety of simple devices for triggering the valve action.

Seven models are currently available: solenoid, cam-operated, palm button, finger-tip, foot-operated, and two types with a hand lever.

The opening, closing, and holding action are effected by the pressure of the air or liquid. The valving action works with the pressure instead of against it.

The valve body is machined from solid bar steel with a corrosion resistant finish and is equipped with Buna-N rubber diaphragms. The valve is adapted for applications up to 125 psi and under temperature variations from −40 to 225 deg F.

A momentary electric impulse triggers the solenoid-operated model to open or closed positions. No current is required to hold since there is no prolonged flow of current.

Literature illustrating and describing the valves is offered by the manufacturer.

More information? Circle Item 31 on postcard, page 105.

Copper Tubing Saw

A saw has been designed for cutting copper tubing exclusively, by Collins Machinery Corp., Los Angeles, Calif.

From seven to eight pieces of ¾- and ½-in. copper tubing can be cut by the saw at one time. A tubing length indicator assures accurate cutting.

The saw can be operated by one man and requires no special skill. Power is supplied from a 110-v electrical outlet. No special wiring is required, and no setup time is necessary.

Made of aluminum, the saw weighs approximately ninety pounds.

More information? Circle Item 32 on postcard, page 105.

3-Lead Temperature Meter

A temperature meter which allows simultaneous readings to be taken in three separate areas is introduced by Simpson Electric Co., Chicago.

The instrument, Model 385-3L, has three test leads which can be placed in different locations. A switch allows the operator to get readings on the meter's single dial from each location without moving the leads or the instrument itself.

In practice, one of the leads might be put in a refrigerator's freezer compartment, another in a central position in the box, and the third lead in the bottom area of the refrigerator. The operator can then, by means of the switch, test the temperature in all three portions of the refrigerator without moving the instrument or the leads.

Measuring 3 x 5⅞ x 2½ in., the instrument is capable of recording temperatures from 70 deg above to 50 deg below 0 F. It can be used for measuring the temperature of water and other liquids in addition to testing refrigeration units and industrial cold storage areas.

More information? Circle Item 33 on postcard, page 105.

Hot Water Manifolds

A line of manifolds for hot water, baseboard, and panel heating systems is made by Econo Products Co., East Haddam, Conn.

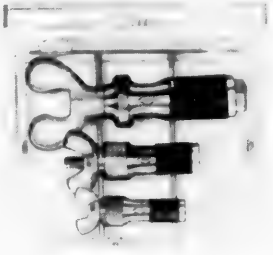
Named Zone-a-trol, the manifolds are available in straight, in-line models with from four to eight outlets in 1- and 1¼-in. sizes with either ⅜, ½, or ¾-in. outlets. They can be installed to accommodate complex system layouts.

For baseboard heating installations, special baseboard valves are offered with either two or three outlets and are available in 1- and 1¼-in sizes with ¾-in. outlets.

More information? Circle Item 34 on postcard, page 105.

Test Plug Kit

A set of three test plugs, for use in temporarily shutting off ½, ⅝, and ⅞-in. OD tubing (⅜, ½, and ¾-in. nominal sizes), is announced by The Imperial Brass Mfg. Co., Chicago, Ill. The plugs are packaged in a plastic box with a hinged lid, and the sizes are identified.



The test plugs can be used where it is desirable to shut off the end of a tube temporarily without pinching it off or installing a valve. Applications in which they can be used include plumbing, heating, instrumentation, refrigeration, and LP-gas work.

The plug is inserted in the end of a tube and the wing nut is tightened. This expands the synthetic rubber portion of the plug and seals the tube. The plugs will hold pressures up to 100 psi and can be used on liquid or gas lines, except those carrying materials that would deteriorate synthetic rubber.

The test plug set is identified as No. 142-F and is described in Bulletin No. 3057, available from the manufacturer.

More information? Circle Item 35 on postcard, page 105.

Recording Thermometer

A maximum-minimum recording thermometer is made by Pacific Transducer Corp., Los Angeles, Calif.

Named Pandux, the instrument measures ambient temperature and records both the lowest and the highest values over a given period of time. It has a replaceable paper chart on which a permanent record of temperatures is recorded. The chart can be replaced and filed for future reference by unscrewing a thumb nut in the bottom of the case.

The thermometer comes in two ranges: 50 to 250 deg F (Model 581-F) or −50 to 100 deg C (Model 581-C). Among the uses of a recording thermometer of this type are: recording of refrigerator or freezer storage temperatures; keeping records of the maximum and minimum temperatures in enclosures, such as hospital rooms, offices, assembly halls, and theatres; and evaluating heating and air conditioning systems over a period of time. It can also be used for recording the total excursion of the temperature in low temperature ovens, incubators, curing rooms, and green houses.

More information? Circle Item 36 on postcard, page 105.

Arc Welder Line

An expanded and improved line of arc welders, called Sureweld, is offered by National Cylinder Gas Co., Chicago, Ill.

Included in the line—numbering ten different types and ninety-eight models—are a-c welders (illustrated), d-c rectifier welders, a-c inert arc welders, combination a-c/d-c welders, and portable, engine-driven, d-c welders.

The d-c rectifier welder group has been expanded to include four different types: the DRCV series constant voltage welder, for use in inert gas metal arc welding; the DRGA series, designed for maximum crater elimination; the DRH series, a welder featuring horizontal styling and a single current range; and the company's standard general purpose d-c rectifier welder.

The portable, engine-driven d-c unit is the SGW. It is rated at 200 amp and 30v (50% duty cycle) and will handle 3/16-in. diameter electrodes. An added feature is a 1500-watt, a-c power take-off suitable for operating portable electric power tools or for auxiliary lighting.

In the inert arc, a-c welder group are three new welders. They are the ACGA-220 series welder, with mechanical current control, available in 140, 200, and 300-amp models; the ACGA-250 series welder, with electrical current control, available in 150, 235, and 350-amp models; and the GAMA series, with electrical current control and equipped for a-c and d-c metal arc welding in addition to inert arc welding.

A new a-c industrial welder, the ACHD series is made in five models with 60% duty cycle rating of 200, 300, 400, 500, and 600 amp. The a-c shop type welders—the S-30; the S-30C, with power factor correction; and the S-18C—have been retained in the line without change.

The company also offers a line of automatic control units, remote control devices, switches, high frequency units, water coolant mechanisms, and other accessories.

More information? Circle Item 37 on postcard, page 105.

Smaller Room Cooler Cord

A smaller, three-conductor, flat rip cord for use on window-type room air conditioners is announced by General Electric Co., Bridgeport, Conn.

Significantly smaller in size than jacketed types, the cord incorporates a green ground conductor located in a web between two thermoplastic conductors. When the conductors are pulled apart, the green ground wire is exposed. The rip-cord design is flexible and permits stripping and termination of the conductors. The thermoplastic insulation jacket, available in a range of colors, is smooth and can be cleaned.

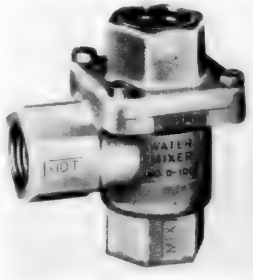
The cord is listed by Underwriters' Laboratories, Inc., in sizes from No. 10 to 18 Awg for 300 volts to replace the Type S jacketed cords.

More information? Circle Item 38 on postcard, page 105.

Water Mixing Valve

A valve designed for blending hot water with cold water is introduced by Bell & Gossett Co., Morton Grove, Ill.

Called the D-100 water mixer, the valve is set at the factory to deliver water at 140 deg F. It is not adjustable in the field. The body is made of heavy forged brass, and all tappings are ½ in. IPS. A solid type of thermostatic expansion element is used in the unit, and all working parts are non-corrosive.



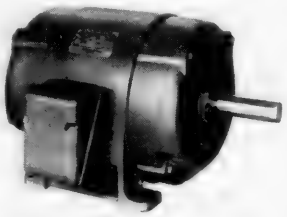
The water mixing valve is suitable for use on all types of direct or indirect fired water heaters where it is necessary to prevent excessively hot water from reaching the fixtures. The valve will also increase heater capacity by preventing too rapid a draw on the available hot water supply. Still further, it can be used to obtain two different water temperatures from a single water heater. The 140-deg water from the valve will supply water for shower and faucet needs, while higher temperature water directly from the heater can be used for dish washing and laundry requirements.

More information? Circle Item 39 on postcard, page 105.

Synchronous Induction Motor

A synchronous induction motor—the Synduction—for general industrial use is announced by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Developed at the firm's Norwood Works, the motor is available in ratings from ¼ to 40 hp, is built on standard induction motor frames and enclosures, and uses a die-cast rotor. The motor requires no brushes, slip rings or windings on the rotor, separate source of direct current excitation, or special starting equipment.



The new machine starts as an induction motor with a very high locked-rotor torque, accelerates and pulls into synchronism, and runs as a synchronous motor. Having a 175 to 200% pull-out torque, the motor remains in synchronism regardless of load or line voltage fluctuations.

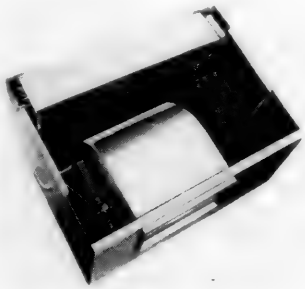
The motor has been designed to operate over a wide frequency, and therefore, a wide speed range. Frequencies of 300 cycles and speed above 10,000 rpm are available. Motors for frequencies as low as 10 cycles have been developed.

At present, each motor is being engineered for an individual application. Inquiries must include information on load inertia, accelerating time requirements, electrical supply characteristics, speed range, enclosure required, and any other electrical or mechanical information that would affect the design of the motor.

More information? Circle Item 40 on postcard, page 105.

Air-Cooled Condensers

A line of air-cooled condensers to eliminate the need for water in packaged air conditioner installations is announced by United States Air Conditioning Corp., Minneapolis, Minn.



Provided in four models with 2, 3, 5, and 7½-ton capacities, the equipment is expected to find applications in commercial installations where water for refrigerant condensing is scarce or costly or waste water disposal presents a problem.

The units comprise a motor, blower, and condenser coil, housed in a weather-proof cabinet. They are designed to be installed remote from the packaged air conditioner, either in or outdoors, wherever a continuous supply of outside air can be provided. Their installation requires the connection of two copper lines to the air conditioning unit, one to carry hot refrigerant gas from the compressor and the other to return the condensed liquid to the receiver.

The equipment measures 39 in. wide by 27 in. high by 28 in. deep, approximately, in the 2-ton model and 70 in. wide by 50 in. high by 30 in. deep in the 7½-ton unit. Electrical requirements are single-phase, 230v for 2, 3, and 5-ton models and three-phase, 220v for the 7½-ton equipment. A three-phase unit is also available in the 5-ton capacity.

More information? Circle Item 41 on postcard, page 105.

Pumps Are Packaged

To facilitate the stocking, storing, and ordering of end-suction pumps, a packaging plan is introduced by Peerless Pump Div., Food Machinery and Chemical Corp., Los Angeles, Calif.

From over fifty different face-mount and close-coupled pump sizes available, surveys by company sales engineers indicated that twenty-two pump models, ranging from 1 to 15 hp, were the most popular and regularly ordered sizes. The company is now packaging these 22 pumps in reinforced cartons under its redi-pak Fluidyne label.

Bulletin No. B-2319 describes the new service and contains pump descriptions and a selection chart. The bulletin also includes head-capacity performance curves for each of the twenty-two pumps.

More information? Circle Item 42 on postcard, page 105.

Water Mixer

A water temperature control that guards against its own failure is announced by The Powers Regulator Co., Skokie, Ill.

Called the Type N Hydroguard, the thermostatic mixer is for use wherever control of water temperatures is required. Typical installations include bakeries, tanneries, and food, chemical, metal, photographic and petroleum processing plants.

The mixer control shuts the hot water port if the cold water supply fails, or closes the cold water port if the hot water supply fails. Should the thermostatic liquid-filled motor itself fail, a fail-safe provision automatically closes both the hot and cold water poppets.

The mixer holds the water delivery temperature to within plus or minus 2 deg F under any of the following conditions: (1) A 75% drop in inlet pressures. (2) A 45-deg fluctuation in hot water supply temperature. (3) An 85% restriction of discharge flow.

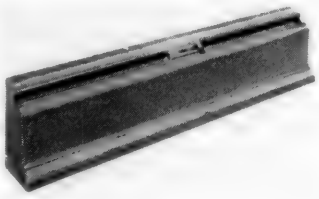
Available in 45- and 125-gpm capacities, the largest mixer is half the size and a third the weight of the similar capacity Type C controller, which it replaces.

Since the outlet and inlets of the mixer can be rotated through a complete circle in 90-deg steps, it can be installed in any position. It is set at the factory to deliver water at any temperature between 65 and 115 deg. An 85 to 160 deg range can be furnished on order. Maximum temperature settings can be lowered by a concealed adjustment, which can be locked to prevent tampering.

More information? Circle Item 43 on postcard, page 105.

Baseboard Diffuser

A warm air baseboard diffuser is available in 2- and 4-ft lengths from Kritzer Radiant Coils, Inc., Chicago, Ill.



Made of 20-gage die formed sheets, the diffuser is available with or without a damper. The damper performs the dual function of a balancing and shut-off blade. It is operated by a lever action control.

Where additional baseboard lengths are required, knock-outs in the diffuser's ends provide a means of extension. The ends are bolted together after the front covers are snapped off. Scorings in the bottom permit fitting the diffuser to the supply boot.

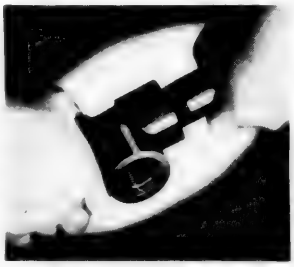
More information? Circle Item 44 on postcard, page 105.

Plastic Pipe

A rigid pipe is being extruded from polyvinyl chloride by American Hard Rubber Co., New York, N. Y.

Made of unplasticized PVC, the pipe, called Riviclor, has an impact strength of 2.5 (Izod), and the material retains its strength at sub-zero temperatures.

Resistant to electrolytic corrosion, the pipe is recommended for underground lines as well as plant piping. It can also be specified for food and beverage lines.



Both pipe and fittings are available from the company in sizes from ½- to 2-in., in standard or extra heavy wall construction (schedules 40 and 80 IPS). The working pressure of the ½-in. extra heavy pipe is 490 psi, and that of the 2-in. extra heavy pipe is 255 psi, at 70 deg F. Though the recommended maximum pressure decreases as the temperature increases, the pipe can be used safely and will retain its rigidity at temperatures as high as 160 deg F under most conditions.

Diaphragm valves are also available with plastic bodies in sizes from ½- to 2-in.

The plastic is 1/6 the weight of steel and ½ the weight of aluminum. It can be cut with a hack saw, and threaded and assembled with standard pipe tools. It also can be fabricated by hot gas welding and solvent cement welding. Welded tank liners and special fabricated equipment are also made from the plastic.

More information? Circle Item 45 on postcard, page 105.

Compressor Is Driven by Gas

A refrigeration compressor, that can be driven by a gas turbine is announced by York Corp., Industrial Div., York, Pa.

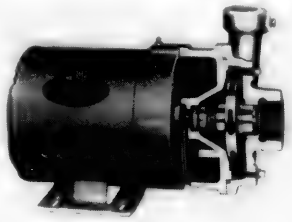
Named the Turbomatic, the compressor is made in capacities ranging from 115 to 350 tons. It is particularly suited to areas where natural gas is available as a fuel for powering air conditioning equipment. In this type of application, gas piping is connected directly to the turbine drive, thereby eliminating the need for a boiler.

The company's water cooling systems incorporating the new compressor are factory assembled and include prefabricated, inter-connecting piping. To facilitate hauling, rigging and erecting, however, the systems are partially dismantled and skidded for shipping.

More information? Circle Item 46 on postcard, page 105.

Air Conditioning Pump

A motor mounted centrifugal pump has been designed specifically for air conditioning service by The Deming Co., Salem, Ohio. The new unit is also suited to general circulating duty, industrial plant service, swimming pools and lawn sprinkling. Sizes range from ⅓ to 5 hp with capacities to 140 gpm.



Design features of the pump include a bronze, enclosed type impeller; a renewable, bronze wearing ring; a stainless steel shaft; and a rotary type shaft seal. Its casing may be turned for horizontal or vertical discharge. The suction and discharge nozzles are cast integral with casing and threaded for pipe connections. Drain, vent and priming connections are also provided.

The motors are ball bearing, single or three phase, 3450 rpm and are equipped with bearings that are lubricated with grease.

More information? Circle Item 47 on postcard, page 105.

Small Pressure Valve

A small size pressure reducing and regulating valve is added to the Cash Standard line by A. W. Cash Co., Decatur, Ill.

Known as the Type 3381, the valve, which is 5⅝ in. high and 2⅝ in. face to face, provides pressure control of air, water, oil, steam, and most liquids and gases. Its body and trim are bronze; the seat and diaphragm are bronze or composition. Available sizes are ¼ and ⅜ in. with screwed ends (⅛ in. on special order).

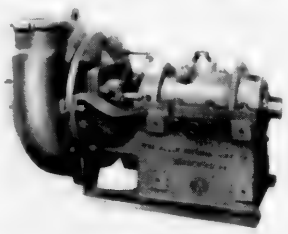
The valve can operate at inlet pressures as high as 400 psi at 150 deg F and 250 psi at 400 deg. Fire spring ranges are available from 5 to 300 psi delivery pressure.

The valve can be supplied with a pressure gage, mounted in either of the two outlet connections. Adjusting screws are available with square head, plastic knob, or wing nut.

More information? Circle Item 48 on postcard, page 105.

Pumps Move Abrasive Materials

An improved line of centrifugal-type pumps designed for transporting mixtures of abrasive materials such as ash, slag and fly ash from power plants and coke from petroleum plants is announced by The Allen-Sherman-Hoff Co., Wynnewood, Pa.



Known as the Hydroseal line, the pumps are available in two types and many sizes. One type employs rubber, Neoprene, or other synthetic lining and is suitable for pumping fine solid materials, especially where resistance to chemical action is important. A second type employs hard metal alloy wearing parts and is suitable for handling sharp edged solids that would tend to cut the softer, non-metallic linings.

A small stream of clear water flows continuously through the clearance spaces between the rotating impeller and the stationary parts into the shell (volute) and suction eye of the impeller. The clear water protects the shaft, stuffing box and suction seal from abrasive-laden water and prevents frictional wear and the enlargement of running clearances between moving parts. It also forestalls recirculation of the solid-fluid mixture back to the suction eye of the impeller.

Any fixed pumping condition can be maintained without changing motor or pump speed. However, a change of the V-belt drive ratio will adapt the same pump to a range of capacities and heads.

More information? Circle Item 49 on postcard, page 105.

Nipple Fittings

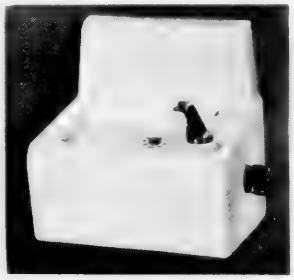
Standard and extra heavy nipples are added to the Anvil Brand line of steel pipe fittings made by Pittsburgh Pipe & Coupling Co., Allison Park, Pa.

The company now offers a standard line of forged seamless and wrought steel pipe fittings—including couplings, bushings, nipples, and plugs—through distributors to the plumbing and heating trade.

More information? Circle Item 50 on postcard, page 105.

Drinking Fountains

Drinking fountains designed to harmonize with modern architecture and to prevent contamination are offered by Plumbing and Heating Div., American Radiator & Standard Sanitary Corp., Pittsburgh, Pa.



Four models are offered in vitreous china, available in seven colors and white, with non-tarnishing Chromard fittings. They include: the Calistoga, a high back model with push button glass filler; the Saratoga (illustrated), a wall-hung model with a low back; the Sharon, a re-designed, wall-hung model; and the Tioga, a re-designed, semi-recessed model.

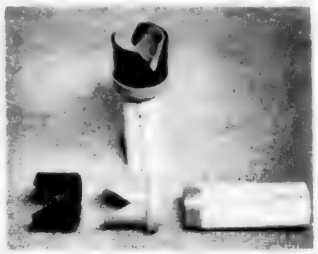
The drinking fountains are equipped with a shield, to prevent direct contact with the nozzle, and an anti-squirt device. The anti-squirt device is a slot milled horizontally into the waterway; if the nozzle opening is covered, water is directed through the slot and downward into the bowl area.

Measurements of the four drinking fountains are as follows: Calistoga, high back, 14 x 22¼ x 13 in.; Saratoga, low back, 14 x 15¼ x 13 in.; Sharon, compact, 14 x 10 x 13 in.; and Tioga, semi-recessed, 14 x 26 9/16 x 6½ in.

More information? Circle Item 51 on postcard, page 105.

Tower Bleed-Off Control

A triangular weir for the adjustment and control of bleed-off in cooling towers and evaporative condensers has been developed and patented by Deady Chemical Co., Kansas City, Kan.



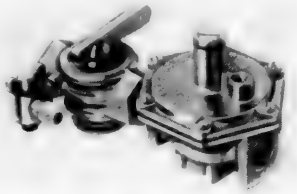
The weir provides a variable bleed-off for the control of concentrations and also acts as a skimmer for the removal of suspended solids and surface trash, such as dead algae and slime. Scale deposition and corrosion can be reduced and controlled by varying the concentrations and using properly formulated chemical treatment.

The unit is mounted by cutting and threading the overflow pipe so that the assembled height, with the weir, will be the same as the original overflow pipe. The volume of bleed-off is controlled by turning the sleeve fitting, thereby adjusting the depth of the notch. The entire unit is machined from Saran plastic.

More information? Circle Item 52 on postcard, page 105.

Gas Regulator Assembly

A manual shutoff valve and a regulator valve assembly (illustrated) are introduced by Major Controls Co., Corona, Calif. Each unit is made of aluminum and is certified by the AGA.



The manual shutoff valve—for furnaces and heaters—is available in two models: the C-300 or ½-in. size and the C-400 or ¾-in. size. The regulator valve assembly is made up of the C-300 or C-400 valve; a pilot valve, with or without throttle adjustment; and a pressure regulator.

All valve parts are manufactured in the company's die-casting and machine shops, which enables it to make shipments direct to appliance manufacturers.

More information? Circle Item 53 on postcard, page 105.

(*Continued on page* 126)

what they are doing with

REVERE COPPER WATER TUBE

FIRST LUTHERAN CHURCH

Glendale, Calif.

FINDS IT THE ECONOMICAL ANSWER FOR ITS RADIANT PANEL HEATING SYSTEM

Architect: ORR, STRANGE & INSLEE, Los Angeles. General Cont.: UNITED LUTHERAN CHURCH, Represented by REVEREND EDWARD SPIRER. Heating Cont.: HESS BROS., N. Hollywood. Revere Dist.: EDWARDS SUPPLY COMPANY, N. Hollywood & Azusa.

On this job the 5,000 feet of ½" Type L Revere Copper Water Tube in standard 60' lengths meant fewer fittings. The sure soldering of copper meant tight joints. The non-rusting qualities of copper means no clogging or reduction of flow. Wrap up all the advantages of using Revere Copper Water Tube in radiant panel heating systems and you have an installation that is low in cost and high in reliability. Ask the contractors. They say copper costs less than rustable materials and can be depended upon to perform for years.

The beauty of heating a church by radiant panels is that traditional as well as modern architectural design may be used without having to allow for outlets or radiators. It is the number one method of heating churches and similar permanent structures. And, when installation is completed panels are invisible.

The inherent qualities of Revere Copper Water Tube also make it the choice of the "on-the-ball" architect and contractor for hot and cold water lines, underground service lines, processing lines, drainage and waste lines, vent stacks. See your Revere Distributor for your needs. And if you have technical problems involving the best way to use Revere Copper Water Tube, one of our Technical Advisors will be glad to help.

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COPPER ★ BRASS ★ 18 01 ★ REVERE ★ ALUMINUM

(*Continued from page* 124)

Spun Duct Insulation

A semi-rigid duct insulation designed for application to exterior or interior duct surfaces is announced by Baldwin-Hill Co., Trenton, N. J. and Huntington, Ind.

Felted from spun mineral wool fibers, the insulation is available in three types: plain; with an integral vapor barrier for application on duct exteriors; or coated with Neoprene for application on duct interiors. The Underwriters' label has been applied for both the plain and Neoprene-coated duct insulation.

Composed of non-cellular, spun mineral wool, the material can be cut with a knife to conform to irregularly shaped or curved surfaces. It will not absorb moisture, but when applied where condensation is a problem the vapor barrier type should be used.

Applied by any of the currently acceptable methods, the insulation comes in 24 x 48-in sheets with thicknesses of ¾, 1, 1½ and 2 in. It has a density of 6 lb per cu ft; a thermal conductivity of 0.24 Btu (in.) per (hr) (sq ft) (deg F) at 75 deg F, and will withstand temperatures to 450 deg.

More information? Circle Item 54 on postcard, page 105.

Medium-Size Incinerator

A 4-bushel, automatic, gas-fired incinerator is added to Incinor line by Bowser, Inc., Incineration Div., Chicago, Ill.

In announcing the new model, the company pointed out that the unit's 4-bushel capacity is intended to fill a gap between the small home-type unit and the larger heavy duty commercial models.

Known as the Model C, the incinerator is suitable for small commercial, industrial, and institutional applications. An atmospheric, ribbon-type flame burner is used in the unit, which is completely automatic and approved by the AGA for use with natural, manufactured, mixed propane, and LP gases.

Specifications and performance data are available from the manufacturer.

More information? Circle Item 55 on postcard, page 105.

Roll Formers Are Modified

Slip roll forming machines are being built in modified models for forming obround and rectangular shapes by Niagara Machine & Tool Works, Buffalo, N. Y. Both power and hand operated machines can be equipped with this feature.

With optional equipment, the slip roll formers can alternately produce curved and flat surfaces for the production of obround tanks and containers, round cornered rectangular pipe sections, and similar objects.

On the 6-in. diameter machine, the rear roll is positioned pneumatically between two limits to alternately form curves and flats. On smaller diameter machines, the rear roll action is mechanical.

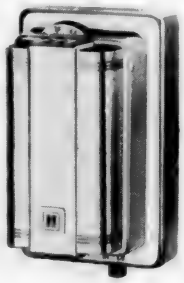
A layout on the sheet, with markings where curves begin and end, is all that is required as a guide. Flat surfaces are formed into curves by the continuous rotation of the rolls during radius changes.

Descriptions of the new modification, as well as the complete line of slip roll forming machines, are contained in Bulletin 77E.

More information? Circle Item 56 on postcard, page 105.

Individual Room Thermostat

A thermostat has been developed by Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., for hotels, motels, and other buildings which require individual room temperature control when occupied and manual setback of temperature, to conserve fuel, when vacant.



The low-voltage unit consists of two thermostats and a manually-operated, high-low changeover switch. It enables maids, bellmen, managers, and others to switch to an economical temperature setting when the room is not occupied yet gives guests control over the room temperature when they are in the room.

The high setting is adjustable between 67 and 75 deg F. A snap of the switch at the base of the control changes to a fixed (55-deg) low setting.

Designated T29B, the thermostat can be used to control either electric radiator valves in individual room temperature installations or to monitor motors on zone valves. It is provided with a locking cover to prevent tampering. Its dimensions (including sub-base and changeover switch slider) are 5¼ in. high, by 2 15/16 in. wide, by 2 9/16 in. deep.

More information? Circle Item 57 on postcard, page 105.

Cooling Pumps

Close-coupled air conditioning and refrigeration pumps are being supplied by Lancaster Pump and Mfg. Co., Inc., Lancaster, Pa. with ceramic seat seals as standard equipment on all models up to 7½ hp.

Designated Type M, the pumps are equipped with bronze impellers and shaft couplers in addition to four-position indexing.

A catalog which includes a description of self-priming models up to 1½ hp is available.

More information? Circle Item 58 on postcard, page 105.

(*Continued on page* 128)

THE MARK OF QUALITY

BARBER COLMAN

uni-flo

Engineered Air Distribution

Performance *Guaranteed* with Venturi-Flo ceiling diffusers

1 Opposed-blade volume control operated through face of diffuser

2 Allen head adjusting screw raises and lowers inner assembly to produce deflections ranging from horizontal to vertical

Barber-Colman *guarantees* performance of Venturi-Flo Ceiling Diffusers when they are used according to published data. With Venturi-Flo you get a high rate of aspiration for efficient diffusion, quiet operation. Deflection and opposed-blade volume controls are quickly and easily adjustable after installation. Rigid construction prevents damage during shipping and installation. Select from a wide range of sizes and styles, both recessed and surface types. Contact your nearby Barber-Colman Field Office, or write . . .

Barber-Colman Company

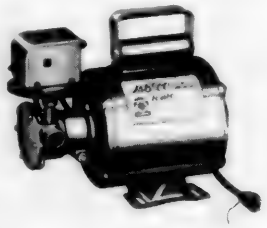
DEPT. F, 1102 ROCK STREET, ROCKFORD, ILLINOIS, U. S. A.

(*Continued from page* 126)

Portable Pump and Motor

A close-coupled, portable electric motor and pump unit with a dry suction lift of approximately fifteen feet is made by Jabsco Pump Co., Burbank, Calif.

Designated as Model 2187-50, the unit consists of a bronze self-priming pump, with a Neoprene impeller, mounted directly on the shaft of a ¼-hp, 1725-rpm electric motor, incorporating a vacuum switch that automatically stops the motor when the liquid supply runs dry.



The pump may be operated untended and will shut off automatically when the pumping job is finished. It has ½-in. inlet and outlet ports that are designed to accommodate standard garden hose couplings.

The pump-motor combination is used for general transfer applications in marine, farm, industrial, and chemical industries. It operates on 115-v, 60-cycle, single phase a-c.

With a capacity of 10 gpm against a 10-ft head the pump is suitable for use up to 20 psi. The overall assembly measures 6½ x 11½ x 10 in. high and weighs approximately twenty-seven pounds. It is sold complete with a 6-ft motor cord.

Bulletin 2187 gives the specifications of the unit.

More information? Circle Item 59 on postcard, page 105.

Hot Water Boiler

A hot water boiler is available in nine models from Raypak Co., Inc., El Monte, Calif., for radiant panel baseboard, radiator, and convector heating systems.

Models are also available to supply restaurants and other commercial establishments with 180-deg F water and to provide large quantities of warm water for swimming pools.

Gas-fired, the boilers are equipped with automatic safety controls. They are approved by AGA and are made to comply with the ASME code.

Catalog No. 67 lists the specifications and dimensions of the boilers.

More information? Circle Item 60 on postcard, page 105.

Improved Pump Bearing

An adjustable thrust and guide bearing made of Teflon has been developed by Eco Engineering Co., Newark, N. J., for its standard line of Type 20 alloy, submersible, centrifugal pumps.

The fluid pumped acts as the lubricant since the Teflon bearing is in rotational contact with a Teflon sleeve on the pump shaft. Thus the user is not confronted with the possibility of lubricant contamination or bearing failure due to improper or lack of lubrication.

Weighing less than 100 lb, the entire pump unit is portable and can be moved by lift truck for discharging vats or tanks at different locations. One pump can handle dissimilar chemicals since it is not limited by choice of bearing materials or lubricants. The combination of Type 20 stainless steel and chemically inert Teflon permits using the pump for severe corrosive service.

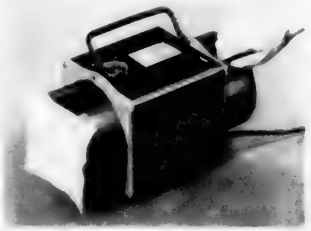
The Teflon permits the pumps to be chemically or steam sterilized, or both, without the need for disassembling the bearing. The vertically split, tapered bearing, identified as the Collecton, is adjustable with a threaded Teflon lock nut and is similar in action to a machine tool collet. This type of assembly permits the removal of the bearing components without disturbing the pump shaft, impeller setting, or pump housing.

Furnished in heights to 60 in. from the base, the pumps are furnished with statically and dynamically balanced, closed or semi-open impellers. Maximum particle size when handling suspensoids or slurries is 1/16 in. Capacities to 45 gpm and heads to 50 ft are offered.

More information? Circle Item 61 on postcard, page 105.

Air Contaminant Collector

An instrument which enables the measurement of airborne contaminants taken from large samples of air has been developed by Mine Safety Appliances Co., Pittsburgh, Pa. The instrument is used to collect contaminants to be weighed and analyzed in connection with industrial hygiene or air pollution problems.



A feature of the instrument, known as the Fixt-Flo air sampler, is an automatic flow control which compensates for changes of filter resistance caused by collected material.

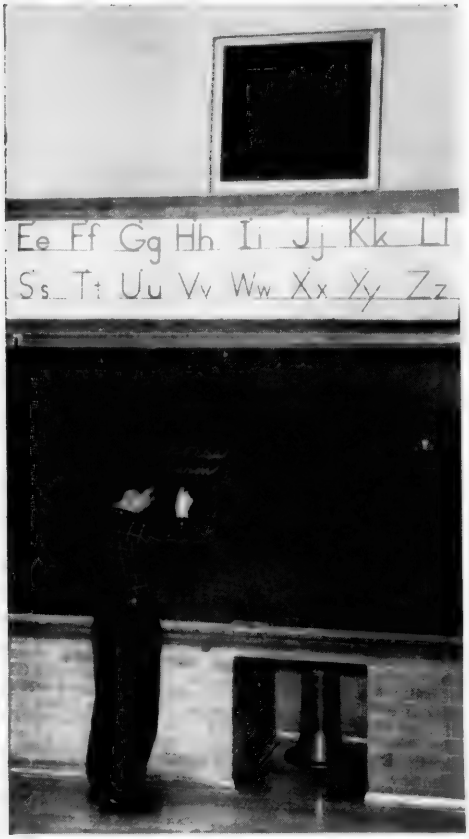
Automatic control of air flow rate is provided by a compensating damper in a bypass duct for unfiltered air. Filtered air enters a plenum chamber and passes through a fixed orifice in a spring-loaded diaphragm plate. As filter resistance increases, pressure in the plenum chamber decreases, thus releasing the diaphragm plate to close a switch that starts the bypass damper motor. The damper reduces the bypassed air flow, thereby increasing suction through the filter. Changes in supply voltage also cause damper operation to increase or decrease the bypassed air flow and thus maintain constant air flow volume through the filter.

A variety of filter media can be used without knowledge of their specific resistances. Filters can be cut from bulk material. Any of three flow rates may be selected by the user: 15, 30, and 50 cfm. The sampler is 7¼ x 7¼ x 15 in. and weighs 13½ lb. It operates from a 110-v, 60-cycle power supply.

More information? Circle Item 62 on postcard, page 105.

(*Continued on page* 130)

How new heating and ventilating system cuts schoolroom construction costs . . .



Dunham VARI-AIR Unit, concealed in mixing flue behind blackboard, mixes fresh and recirculated air—silently diffuses it to classroom through overhead grille.

Dunham VARI-AIR—designed to help the "hard-pressed" budget . . . and save valuable floor space

School construction costs can't go anywhere but down when Dunham VARI-AIR heats and ventilates classrooms. This new system satisfies all health and comfort standards . . . does it at a cost that meets with full approval of any school board member.

In addition to healthful, silent heating and ventilating, VARI-AIR puts school air conditioning within easy financial reach of construction budgets. This optional use of VARI-AIR can be economically provided for when the system is installed.

Offers Numerous Advantages

Lower Costs: Dunham VARI-AIR eliminates need for in-the-room cabinet ventilators . . . provides greater savings in classroom heating construction costs. Total absence of complex controls saves both first and maintenance costs.

Minimum Temperature Variations: Dunham's centralized temperature control system holds room temperatures within prescribed limits by automatically compensating for weather change and heat loss.

Space Saver: No floor space in classroom is given over to either heating or ventilating with a Dunham VARI-AIR system.

How VARI-AIR Operates

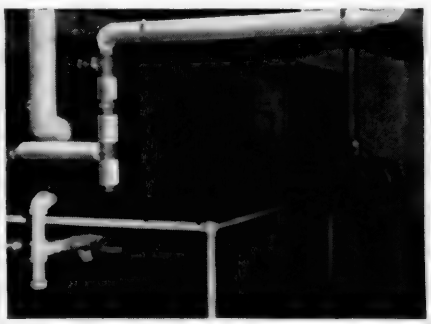
Only three primary parts to the system. VARI-AIR Units are concealed in wall spaces, mix fresh and recirculated air and diffuse it into classrooms.

Heating and Ventilating Unit—generally one to the entire system—pulls in fresh outside air, tempers, filters and discharges it through a tunnel or ceiling plenum to the VARI-AIR Unit.

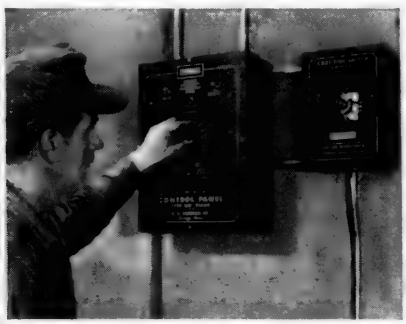
Radiation—Dunham THERMO VECTOR® "along-the-wall" radiation saves floor space and provides all necessary heat whether used with steam or hot water.

For complete information, contact any Dunham Representative or mail the coupon.

Dunham Finned-Pipe Radiation runs along outside walls, under windows to eliminate chilling downdrafts, save premium classroom floor space.



Dunham Heating and Ventilating Unit pulls in outside fresh air and tempers, filters and discharges it through a tunnel or ceiling plenum to VARI-AIR Units.



Dunham VARI-VAC® Temperature Controls provide centralized operating station for *all* system settings and readings. This electronic "brain" helps system save up to 40% on fuel.

DUNHAM **HEATING & COOLING EQUIPMENT**

RADIATION • CONTROLS • UNIT HEATERS • PUMPS • SPECIALTIES

C. A. DUNHAM COMPANY • CHICAGO • TORONTO • LONDON

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Dept. ACHV-6, 400 W. Madison Street
Chicago 6, Illinois
Please send VARI-AIR literature.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

(*Continued from page* 128)

Room Cooler Fan

A 6-bladed fan with reduced axial depth has been developed by The Torrington Mfg. Co., Torrington, Conn., primarily as a condenser fan (with a slinger ring) in room air conditioners.

Available also with four blades, the Type C-12-6 axial-type impeller has a 12-in. tip diameter and can be used with either a solid or rubber-bushed hub.

With or without the slinger ring shown in the photo, the fan may be obtained in a variety of pitches. The 6-bladed model includes three 2-bladed, one-piece sections nested together and secured by the hub. The slinger ring is made in one piece, and the slinger-ring tabs are part of the blades themselves.

The axial depth of fans in the series varies from 1 15/16 to 3 5/16 in.

More information? Circle Item 63 on postcard, page 105.

Low Temperature Compressors

A line of motor-compressors for low temperature commercial refrigeration is introduced by Copeland Refrigeration Corp., Sidney, Ohio.

The line includes four air-cooled models in 1, 1½, 2, and 3-hp sizes. A fifth model, 5-hp, is water-cooled. The motor-compressors are designed for F-12 refrigerant.

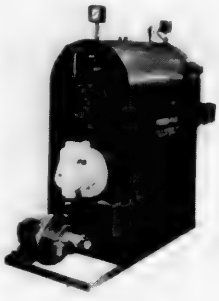
The recommended evaporating temperature range is from −10 to −40 deg F on the 1, 1½, 2, and 5-hp models and 0 to −40 deg on the 3-hp model.

More information? Circle Item 64 on postcard, page 105.

Small Automatic Boiler

A packaged, automatic, low-pressure boiler for oil and gas firing is announced by Orr & Sembower, Inc., Reading, Pa.

Named Power-Pak, the boiler is designed to provide steam or hot water heating or hot water service with power demands of 10, 15, 20 and 25 hp. It may be used in such applications as smaller schools, office buildings, apartments, greenhouses, hospitals, and churches. It is also intended for auxiliary use in large industrial plants and warehouses.



The burner is mounted on the boiler, and the ignition transformer is mounted on the air plenum. On oil-fired models, a single motor drives both the forced draft blower and the fuel pump.

Safety valve, pressure control, and gages are accessible on the top and at the side of the boiler; the motor starter is located at the right of the motor itself. Located below the removable, inspection and cleaning door at the front of the boiler is a peep sight through which the combustion process may be observed.

At the back of the boiler above the stack connection outlet, provision is made for tank or tankless heating coils, which may be added for hot water service to baths, washrooms, and other outlets. The return connection is on the side of the boiler at the water line, and a blowdown or drain connection is built in at the bottom of the boiler.

The 10-hp oil-fired unit is 61 in. long, 34 in. wide, and 66 in. high, and weighs 1750 lb. The 25-hp boiler is 86 x 36 x 74 in. and weighs 2800 lb.

The gas-fired, 10-hp unit measures 67 x 34 x 66 in. and weighs 1750 lb. The 25-hp unit is 92 x 36 x 74 in. and weighs 2800 lb.

Equipped with forced draft, the unit meets ASME standards of five square feet of heating surface per boiler horsepower throughout its full range.

More information? Circle Item 65 on postcard, page 105.

Double Apron Bathtub

A two-sided bathtub with a completely finished apron on each side is available from AllianceWare, Inc., Alliance, Ohio.

Named the Alliance, the bathtub serves two bathrooms, each bathroom complete with one or more lavatories and water closets.

After installation, the bathtub has a sliding opaque shower door riding a track on each rim, enclosing the bathtub from either or both sides. It makes possible two complete, full size bathrooms in little more space than formerly was required for one. The two sliding doors—one on each side—put the bathtub in the private use of either bathroom as desired.

Where space and cost are problems, the bathtub makes it possible to plan two bathrooms where otherwise only one could have been considered.

More information? Circle Item 66 on postcard, page 105.

Cold Galvanizing Compound

A cold galvanizing compound, called Drygalv, that prevents rust, protects iron and steel surfaces, and repairs damaged galvanizing is placed on the market by American Solder & Flux Co., Philadelphia, Pa.

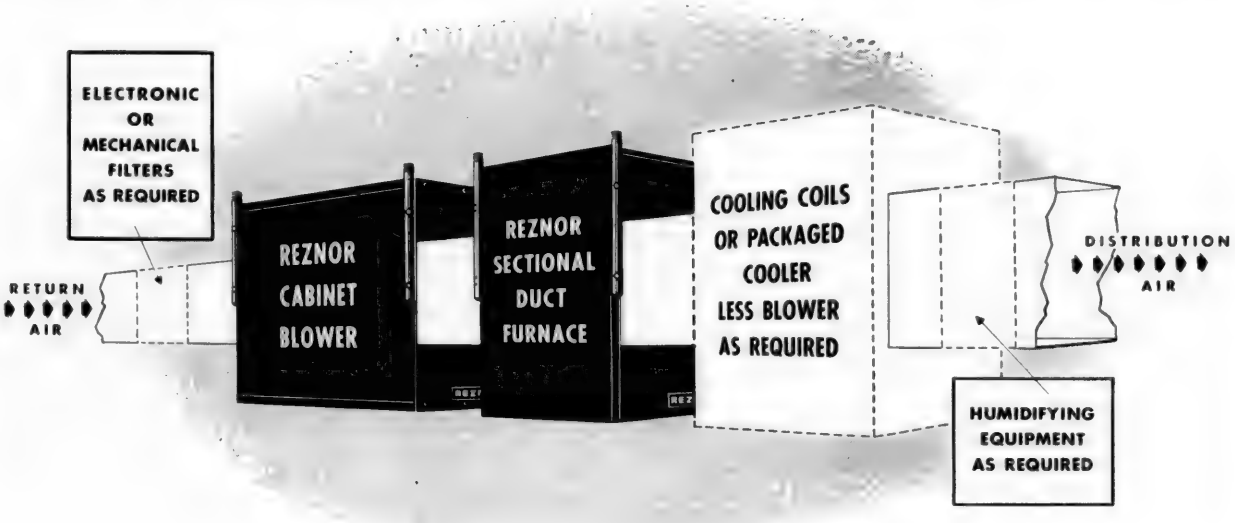
Applied like paint either with a brush or spray gun, the compound produces a coating with a high proportion of metallic zinc—approximately 95% in the dried film. This coating affords the same protection as galvanizing.

Non-toxic, the compound dries to the touch in 15 to 30 minutes and can be second coated or painted in 8 hours. It will withstand temperatures up to 392 deg F for a limited time so that it can be used in manufacturing processes where high temperatures are necessary.

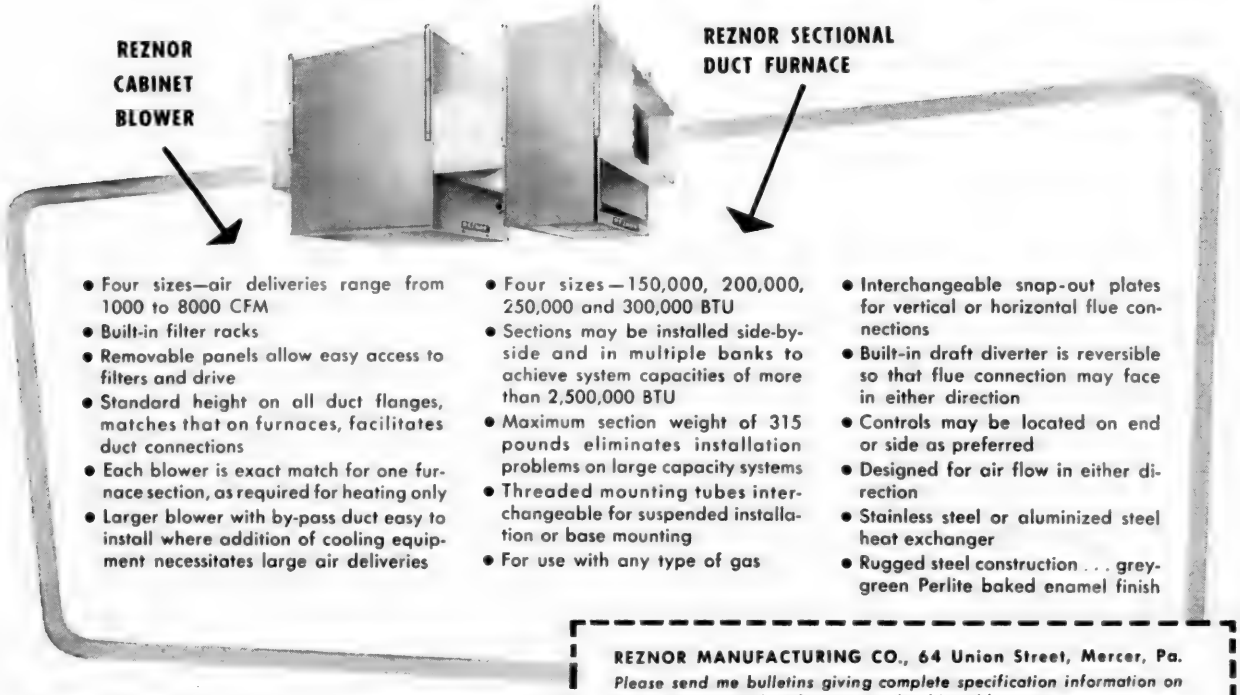
More information? Circle Item 67 on postcard, page 105.

(*Continued on page* 132)

Here's the right start for a *custom*-*engineered* heating-cooling system


ELECTRONIC OR MECHANICAL FILTERS AS REQUIRED
RETURN AIR
REZNOR CABINET BLOWER
REZNOR SECTIONAL DUCT FURNACE
COOLING COILS OR PACKAGED COOLER LESS BLOWER AS REQUIRED
DISTRIBUTION AIR
HUMIDIFYING EQUIPMENT AS REQUIRED

You complete the picture by specifying additional components to meet *exact* job requirements



- Four sizes—air deliveries range from 1000 to 8000 CFM
- Built-in filter racks
- Removable panels allow easy access to filters and drive
- Standard height on all duct flanges, matches that on furnaces, facilitates duct connections
- Each blower is exact match for one furnace section, as required for heating only
- Larger blower with by-pass duct easy to install where addition of cooling equipment necessitates large air deliveries

- Four sizes—150,000, 200,000, 250,000 and 300,000 BTU
- Sections may be installed side-by-side and in multiple banks to achieve system capacities of more than 2,500,000 BTU
- Maximum section weight of 315 pounds eliminates installation problems on large capacity systems
- Threaded mounting tubes interchangeable for suspended installation or base mounting
- For use with any type of gas

- Interchangeable snap-out plates for vertical or horizontal flue connections
- Built-in draft diverter is reversible so that flue connection may face in either direction
- Controls may be located on end or side as preferred
- Designed for air flow in either direction
- Stainless steel or aluminized steel heat exchanger
- Rugged steel construction . . . grey-green Perlite baked enamel finish

THERE IS NO "EQUIVALENT" FOR REZNOR GAS HEATERS

REZNOR
THE WORLD'S LARGEST-SELLING GAS UNIT **HEATERS**

REZNOR MANUFACTURING CO., 64 Union Street, Mercer, Pa.
Please send me bulletins giving complete specification information on Reznor sectional duct furnaces and cabinet blowers

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____

(*Continued from page* 130)

Commercial Exhausters

Standard and heavy duty, commercial, power exhausters have been developed by Quickdraft Co., Canton, Ohio. for handling industrial venting applications and commercial heating plants without exposing fan blades and motors to exhaust gases.

Mounted outside the exhaust units, fans and motors run in clean room air or in ducts that supply clean outside air. The unit is designed to direct air into a conical jet that draws exhaust gases into the unit and forces them into the atmosphere.

The power exhausters do not require a stack for either industrial venting or heating plant installations. When permitted by local codes they can be used to exhaust through building walls or roofs.

The units are built in eight sizes for vent diameters of 12, 14, 16, 18, 20, 22, 24, and 30 in. For exhausting direct to the atmosphere or into standard stacks and chimneys, capacities range from 2360 to 14,616 cfm. Special exhausters can be made for handling greater capacities.

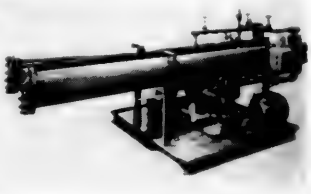
Detailed information and engineering data on both commercial and residential models are published by the company.

More information? Circle Item 68 on potscard, page 105.

Oil Pump and Heater Sets

Fuel oil pump and heater sets that control the pressure and viscosity of heavy industrial fuel oil for better combustion results are available from Walter H. Eagan Co., Inc., Philadelphia, Pa.

Designed to prevent many combusion difficulties brought about by improper field assembled combinations, the sets heat up to 300 deg F, pump to 400 psi, and handle capacities to 3000 gph. Single or duplex sets can be obtained for steam or electric drive and duplex electro-steam sets are also available providing for electrical failure by incorporating one steam pump and one electric motor driven pump.



The sets exceed the minimum requirements of the burner with an adequate safety factor to provide for eventual mechanical wear and future demand increases. All parts requiring maintenance are accessible, and only a few connections have to be made for installation.

Accessories for control and adjustment include suction and discharge pressure and temperature indicators, relief valves, oil suction and discharge strainers. A welded steel base is provided with complete assembly, piping, and wiring.

More information? Circle Item 69 on postcard, page 105.

Air Conditioner Line

A line of packaged air conditioners is offered by Koch Refrigerators, Inc., Kansas City, Kan. The line includes 3, 5, 7½, 10, and 15-hp models. The cabinets are finished in a copper colored enamel to blend with contemporary color schemes.

So that installations may be adapted to various space or temperature conditions, the water, electrical, and drain connections can be brought out through either side depending upon the cabinet's location. The separately framed fan section may be rotated for top-vertical, front-horizontal, or back-horizontal discharge of air. The grille in the plenum is equipped with individual, adjustable louvers so that air can be accurately directed up, down, or to either side.

Each air conditioner is available equipped for either water- or air-cooled installations and may be used with city water or cooling towers. The 3- and 5-hp models may be furnished either single or three-phase; all larger models (7½, 10, and 15 hp) are three-phase and have a ventilating fan for use in mild weather.

In order that the same unit can be used for heating, the company offers optional heating coils; one- or two-row steam or hot water coils may be installed at the factory or added to the unit after it is installed. The company also provides matching air-cooled condensers, water towers, and pumps.

More information? Circle Item 70 on postcard, page 105.

Pitless Well Unit

A pitless type well unit has been designed by Baker Mfg. Co., Evansville, Wis., to meet strict sanitary well codes of State Boards of Health for sealed wells.

Designated Monitor UB, the pitless units provide an unbroken extension of the well casing to above the ground, leaving no place for contamination to enter. They are available in 3½, 4½, 6, and 8-ft burying depths tapped for a 4-in. well casing but can also be bushed for smaller wells. The units feature a 5-in. upper casing that permits a 4-in. opening to give access for drilling tools and well screens.

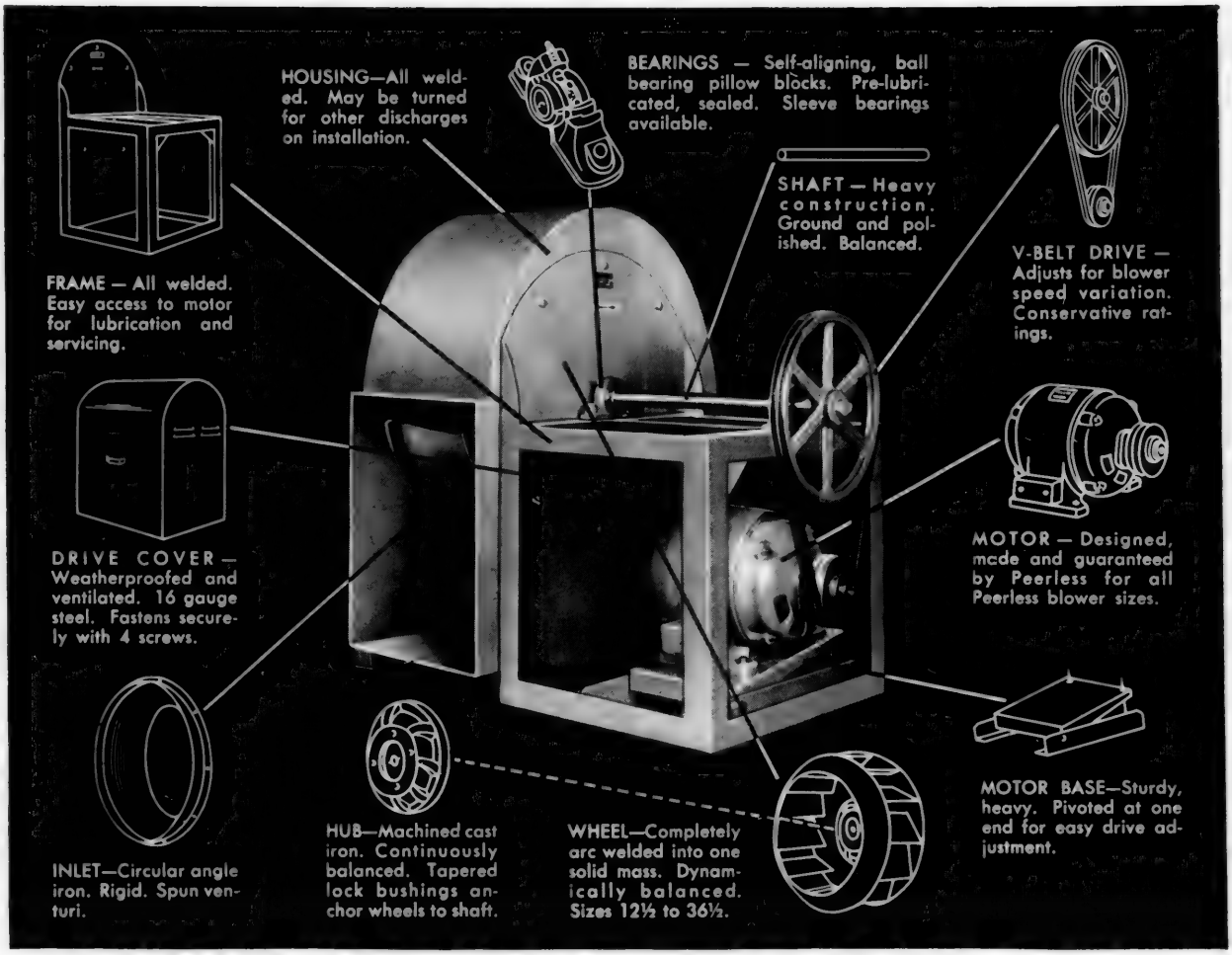
The units are equipped with an air charging system which automatically supplies air to prevent water logging of the tank.

The company manufactures the pitless units for all types and makes of pumps; for any frost level depth up to 8 ft; and for any well casing diameter up to 6 in.

Illustrated literature with details, specifications, and cutaways is available.

More information? Circle Item 71 on postcard, page 105.

(*Concluded on page* 134)


HOUSING—All welded. May be turned for other discharges on installation.
BEARINGS — Self-aligning, ball bearing pillow blocks. Pre-lubricated, sealed. Sleeve bearings available.
SHAFT — Heavy construction. Ground and polished. Balanced.
V-BELT DRIVE — Adjusts for blower speed variation. Conservative ratings.
FRAME — All welded. Easy access to motor for lubrication and servicing.
MOTOR — Designed, made and guaranteed by Peerless for all Peerless blower sizes.
DRIVE COVER — Weatherproofed and ventilated. 16 gauge steel. Fastens securely with 4 screws.
MOTOR BASE—Sturdy, heavy. Pivoted at one end for easy drive adjustment.
INLET—Circular angle iron. Rigid. Spun venturi.
HUB—Machined cast iron. Continuously balanced. Tapered lock bushings anchor wheels to shaft.
WHEEL—Completely arc welded into one solid mass. Dynamically balanced. Sizes 12½ to 36½.

Specially Engineered, Compatible Blower Components . . . The Reason For Outstanding Peerless Performance and Quality!

• This is the Peerless Backward Curve Blower, one of the workhorses of the dependable Peerless line. Like all Peerless units, it's designed, engineered and manufactured completely at Peerless . . . motor and all. It is this complete control from components to finished unit which enables us to unconditionally guarantee every fan and blower we make. Each component works in perfect harmony with the other to give quiet, trouble-free performance.

Peerless Backward Curve Blowers can be specified with confidence. They are thoroughly tested according to test codes. They meet PFMA, NAFM and NEMA standards. Scores of them are operating in schools, hospitals, other buildings and government installations all over the nation. We are used to producing to customer or government specifications.

Write, Wire or Phone Us Today!
Ask for Bulletins SDA-160 or SDA-200

FAN AND BLOWER DIVISION
THE *Peerless-Electric*® COMPANY
FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
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☐ Send me Bulletin SDA-160.
☐ Send me Bulletin SDA-200.

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....

(*Concluded from page* 132)

Small Diameter Pipe Cutter

A portable flame cutting and pipe beveling machine for small diameter pipe (1½ to 4 in.) is announced by H & M Pipe Beveling Machine Co., Tulsa, Okla. The smaller machine weighs 7½ lb and is constructed on the same design principles as larger models.

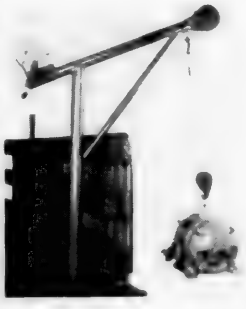
Employing the same split-gear horseshoe principle which characterizes the company's larger units (for pipe up to 36 in.), the smaller model allows its operator to place the machine on continuous pieces of pipe. A quick-operating, boomer strap speeds up the process of changing the machine from one piece of pipe to another.

Changing the unit from one size of pipe to another is done by replacing adapters, properly identified for the various pipe sizes. Any plain-barrel machine cutting torch may be used with the unit.

More information? Circle Item 72 on postcard, page 105.

Truck Hoist Lifts 500 Lb

A hand-operated, portable, truck loading hoist is available through dealers of Hoist Div., Burtchaell Heating Co., Portland, Ore.



Designated Model JF Pacific, the hoist can lift 500 lb with less than a 30-lb pull on the crank. A special snatch block is available which further reduces the crank effort.

The hoist may be removed from the mast well to provide a clear truck bed. It may be used on a shop dolly as well.

The unit is a companion item to the company's 1000-lb capacity power hoist, which has been on the market several years.

More information? Circle Item 73 on postcard, page 105.

Sheet Metal Rivet

A blind rivet for fastening sheet metal is being made by Huck Mfg. Co., Detroit, Mich.

Called the Daisy because its driven appearance closely resembles that flower, the rivet is comprised of a hard aluminum pin with five cutting edges and a hard aluminum sleeve with a large or small washer flange, as desired.

The assembled rivet is inserted into a blind hole from the driving side. A tool is then used to pull the pin head through the sleeve, splitting the sleeve into five levers which spread and curl back against the blind side, pulling the work together and holding it braced, over a large bearing area. In the same operation a swaging anvil flows the outer collar material into the locking grooves on the pin and breaks off the excess rivet pin leaving a stub.

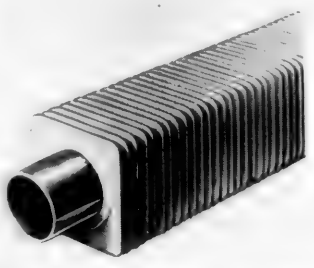
Because of the wide bearing surfaces, the rivet can be used without careful attention to hole size and will withstand substantial loads in shear or stress.

The rivets can be installed by an unskilled operator with either a mechanical hand tool or pneumatic driving tool.

More information? Circle Item 74 on postcard, page 105.

Radiation Element

A steel fin element for commercial radiators is announced by Schemenauer Mfg. Corp., Holland, Ohio.



The element is a combination of 3¼ x 3¼-in. fins on a 1¼-in. iron pipe with 48 fins per ft.

Each fin has a collar which makes contact between fins for proper spacing. It also serves as a bond against loosening. The element can be installed bare or with any of six of the company's cover combinations.

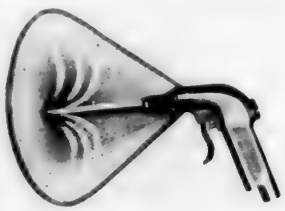
The company is also introducing a new method of packaging the element lengths. Every section has a thick end protector that is removable and prevents possible thread damage in shipping or stocking.

More information? Circle Item 75 on postcard, page 105.

Safety Air Gun

A safety air gun, used for blowing dust or chips from work in progress, is announced by Hydraulic Mfg. Co., Kiel, Wis.

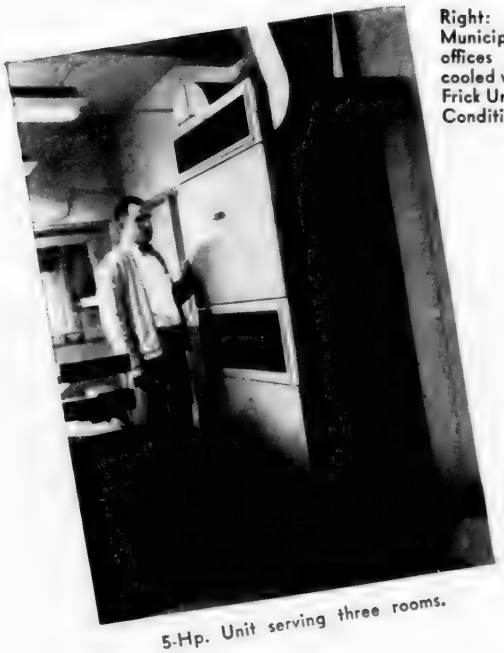
Marketed under the trade name Guardair, the safety gun is designed to protect the operator's eyes, ears, and face from flying chips of metal, dust or other debris, which are blown from the area to be cleaned by the central air jet, shot from the nozzle. A second jet of air, in the shape of a cone, is blown from the gun simultaneously with the central cleaning jet. This cone provides a protective shield or umbrella of high pressure air which prevents debris from flying upward into the operator's face, thereby reducing the hazard of injury to eyes, nose, and face.



The safety gun may be used in any application where air pressure is used for blowing work clean.

The tool itself is designed and balanced to handle with either the right or left hands. The safety air gun operates with a valve which eliminates wasteful air leakage. Force of the air jets emerging from the gun is regulated by the degress of pressure placed upon the trigger.

More information? Circle Item 76 on postcard, page 105.



5-Hp. Unit serving three rooms.

Right: Municipal offices cooled with Frick Unit Conditioners

TRADE FRICK MARK®

Air Conditioning—

Packaged Units or Central Systems

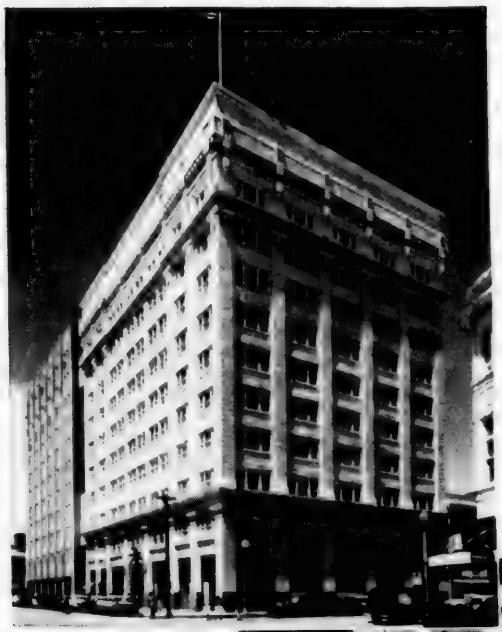
From a 3-hp. unit to a plant requiring thousands of tons of refrigeration is a long step, but they're both included in Frick-engineered air conditioning.

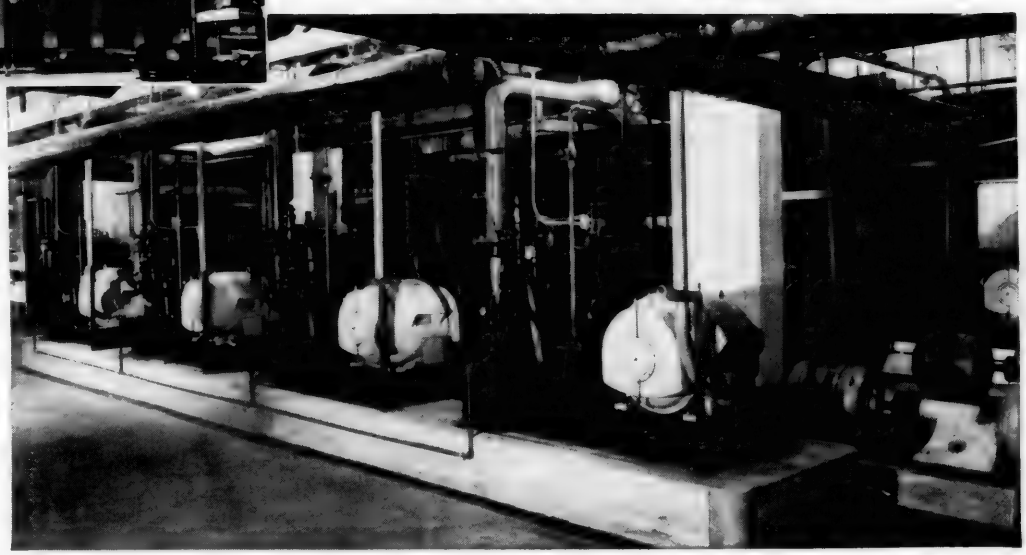
Built into Frick systems are 50 years' experience in air conditioning, nearly 75 in refrigeration, and over 100 in engineering. Nowhere else can you get this unique combination of experience and complete service. Ask for estimates today: write

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.





The two 11-story buildings of the American National Insurance Co., at Galveston, are air conditioned by the multiplicity of 75-hp. "ECLIPSE" compressors shown at right. Thousands of fine buildings are Frick-equipped.

DEGREE-DAYS FOR APRIL, 1956

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

AIR CONDITIONING, HEATING AND VENTILATING's 28th Year of Publication of Monthly Degree-Day Data

City	April			Season to April 30, incl.*		
	1956	1955	Normal	1955-56	1954-55	Normal
Abilene, Texas (A)	135	72	113	2585	2265	2707
Albany, New York (A)	667	455	597	6973	6322	6642
Albuquerque, New Mexico (A)	288	292	289	3835	4157	4319
Alpena, Michigan (C)	800	562	762	7468	6968	7366
Anaconda, Montana (C)	(a)	880	756**	(a)	7615	7493**
Asheville, North Carolina (C)	346	182	285	4150	4031	3962
Atlanta, Georgia (A)	164	56	133	2867	2751	2806
Atlantic City, New Jersey (C)	533	402	468	4751	4474	4528
Augusta, Georgia (A)	164	65	62	2645	2536	2138
Baltimore, Maryland (C)	335	203	326	4329	3994	4130
Billings, Montana (A)	699	606	564	7239	6470	6655
Binghamton, New York (C)	622	411	570	6522	5961	6232
Birmingham, Alabama (A)	173	50	128	2854	2684	2758
Bismarck, North Dakota (A)	819	475	657	9652	7854	8496
Block Island, Rhode Island (A)	671	564	603	5617	5161	5385
Boise, Idaho (A)	424	621	453	5531	6113	5549
Boston, Massachusetts (A)	575	469	534	5792	5262	5506
Bozeman, Montana (C)	(a)	833	731**	(a)	7717	7724**
Buffalo, New York (A)	652	414	636	6509	5944	6405
Burlington, Iowa (A)	508	219	425	6238	5563	5888
Burlington, Vermont (A)	719	557	681	7639	7184	7420
Butte, Montana (C)	(a)	874	741**	(a)	8026	7424**
Cairo, Illinois (C)	236	73	182	3878	3531	3709
Charleston, South Carolina (C)	87	31	43	1882	1822	1769
Charlotte, North Carolina (A)	224	84	172	3227	3081	3176
Chattanooga, Tennessee (A)	231	80	179	3462	3270	3339
Cheyenne, Wyoming (A)	758	659	717	6845	6580	6855
Chicago, Illinois (C)	528	294	518**	5706	5257	5764**
Cincinnati, Ohio (C)	368	144	314	4476	4069	4424
Cleveland, Ohio (A)	566	268	531	5859	5253	5727
Columbia, Missouri (A)	398	121	326	5090	4467	4958
Columbia, South Carolina (A)	154	47	77	2699	2604	2284
Columbus, Ohio (C)	481	243	408	5338	4791	5102
Concord, New Hampshire (A)	748	578	660	7341	6695	7146
Concordia, Kansas (C)	449	177	341	5694	4869	5157
Dallas, Texas (A)	84	52	75	2328	2146	2272
Dayton, Ohio (A)	515	237	435	5652	5120	5373
Deer Lodge, Montana (C)	(a)	786	735**	(a)	7907	7860**
Denver, Colorado (A)	581	444	525	5602	5555	5765
Des Moines, Iowa (A)	523	236	438	6736	5882	6183
Detroit, Michigan (A)	573	311	558	6187	5639	6085
Devils Lake, North Dakota (C)	1000	509	750	10,593	8803	9301
Dodge City, Kansas (A)	439	214	347	5079	4532	4908
Dubuque, Iowa (A)	621	334	543	7265	6600	6892
Duluth, Minnesota (C)	913	597	801	9274	8591	8730
Elkins, West Virginia (A)	569	345	477	5812	5496	5456
El Paso, Texas (A)	132	64	110	2244	2521	2641
Ely, Nevada (A)	704	765	639	6856	7491	6759
Escanaba, Michigan (C)	853	580	804	7882	7298	7863
Evansville, Indiana (A)	371	157	251	4652	4226	4264
Fargo, North Dakota	895	424	687	9827	8448	8769
Fort Smith, Arkansas (A)	214	82	127	3465	3096	3164
Fort Wayne, Indiana (A)	538	264	516	6117	5521	5991
Fort Worth, Texas (A)	97	57	90	2391	2193	2356
Fresno, California (A)	183	300	145	2533	2952	2489
Galveston, Texas (C)	19	9	30	1019	990	1211
Grand Junction, Colorado (A)	371	475	402	5018	5982	5628
Grand Rapids, Michigan (A)	627	358	606	6714	6112	6647
Green Bay, Wisconsin (A)	764	479	696	8031	7391	7715
Greensboro, North Carolina (A)	320	136	241	4041	3629	3760
Greenville, South Carolina (A)	212	77	161	3216	3092	3028
Harrisburg, Pennsylvania (A)	484	291	423	5339	4939	5116
Hartford, Connecticut (A)	631	449	528	6192	5654	5893
Hatteras, North Carolina (C)	217	114	171	2806	2496	2367
Havre, Montana (C)	716	711	597	8810	7273	7717
Helena, Montana (A)	687	767	654	8141	7775	7606
Houston, Texas (C)	30	18	27	1152	1134	1276
Huron, South Dakota (A)	757	311	558	8906	7131	7517
Indianapolis, Indiana (A)	483	235	432	5606	5118	5405
Jackson, Mississippi (A)	133	46	81	2429	2233	2202
Kansas City, Missouri (A)	377	108	292	4970	4294	4769
Knoxville, Tennessee (A)	279	109	196	3736	3513	3540
La Crosse, Wisconsin (A)	664	326	552	7876	6906	7295

(a) Data not available.

*Heating season cumulative, from Sept. 1.

**Same normal figures as previously listed by HEATING AND VENTILATING since new figures are not available. All other normal figures in this table are based on a 30-year period covering 1921 to 1950, inclusive, recently compiled and published by the U. S. Weather Bureau.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y., and Norman E. Ross, Bursar, Bates College, Lewiston, Me., respectively; Anaconda, Bozeman, Butte, Deer Lodge and Livingston, Mont., through the courtesy of the Montana Power Company. Tacoma figures through the courtesy of the Tacoma News Tribune.

[Table concluded on page 138]

SO HALSTEAD & MITCHELL ENGINEERS SAID:

"LET'S INCREASE FINNED SURFACE HEAT TRANSFER"

Announcing "TURBU-FLO"® *finned surface*

Increase turbulence of air flowing over a surface and heat transfer from that surface is increased. Develop a pattern on the surface which will build turbulence to a maximum *within the allowable pressure drop limits* . . . there you have the latest contribution from Halstead and Mitchell engineers . . . the new, exclusive "TURBU-FLO" finned surface!

"Turbu-Flo" assures you of extra-safe ratings for your manufactured equipment, because added heat transfer provides an unusual margin of *added* capacity.

"Turbu-Flo" is manufactured by ultra-modern equipment in our giant Zelienople plant to the exacting quality standards that have made Halstead and Mitchell products distinctive in the air-conditioning and refrigeration industry.

"Turbu-Flo" finned surface is *immediately available* to meet your every need.

Halstead & Mitchell, Bessemer Building, Pittsburgh 22, Pa.

TELL US YOUR NEEDS . . .
AND ASK FOR BULLETIN DE-200

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REMOTE AIR-COOLED CONDENSERS

BLAST HEATING AND COOLING COILS

SPECIAL FINNED EVAPORATORS AND CONDENSERS FOR AIR-CONDITIONING

SPECIAL FINNED COILS FOR REFRIGERATION FIXTURES

Degree-Days for April, 1956 (Concluded)

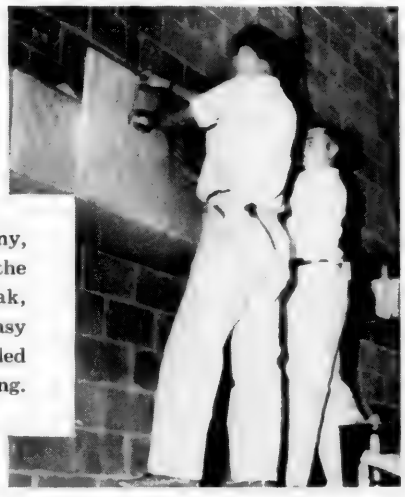
(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

AIR CONDITIONING, HEATING AND VENTILATING's 28th Year of Publication of Monthly Degree-Day Data

City	April			Season to April 30, incl.*		
	1956	1955	Normal	1955-56	1954-55	Normal
Lander, Wyoming (A)	681	706	687	7530	7227	7714
Lewiston, Maine (O)	719	573	693	7042	6756	7318
Lincoln, Nebraska (C)	499	188	377	6162	5384	5654
Little Rock, Arkansas (A)	167	59	122	3105	2846	2964
Livingston, Montana (C)	(a)	703	653**	(a)	6890	6057**
Los Angeles, California (C)	191	128	129	1437	1162	1364
Louisville, Kentucky (A)	348	134	94	4417	4116	4340
Lynchburg, Virginia (A)	356	176	289	4321	4056	4066
Macon, Georgia (A)	105	30	62	2260	2158	2049
Madison, Wisconsin (C)	619	331	573	7122	6571	6915
Marquette, Michigan (C)	852	542	789	7751	7294	7707
Memphis, Tennessee (A)	185	64	139	3248	3028	3113
Meridian, Mississippi (A)	132	50	85	2444	2371	2324
Milwaukee, Wisconsin (A)	652	423	621	6799	6261	6693
Minneapolis, Minnesota (A)	686	328	570	8312	7285	7489
Moline, Illinois (A)	537	236	453	6428	5846	6112
Montgomery, Alabama (A)	116	34	80	2280	2218	2137
Nantucket, Massachusetts (A)	(a)	633	642	(2)	5305	5513
Nashville, Tennessee (A)	249	91	186	3714	3514	3470
New Haven, Connecticut (A)	617	473	567	5831	5398	5695
New Orleans, Louisiana (C)	28	15	19	1171	1116	1175
New York, New York (C)	506	362	456	5059	4724	4879
Newark, New Jersey (A)	516	346	450	5215	4785	5093
Norfolk, Virginia (A)	280	171	265	3577	3359	3395
North Platte, Nebraska (A)	(a)	371	489	(a)	6330	6227
Oak Ridge, Tennessee (C)	252	143	227	3834	3792	3970
Oakland, California (A)	301	415	282	2960	2885	2671
Oklahoma City, Oklahoma (A)	257	117	169	3898	3382	3481
Omaha, Nebraska (A)	502	180	389	6436	5527	5948
Parkersburg, West Virginia (C)	690	207	347	4440	4548	4618
Peoria, Illinois (A)	491	190	435	5953	5419	5843
Philadelphia, Pennsylvania (C)	462	285	369	4708	4304	4430
Phoenix, Arizona (A)	55	37	62	1318	1433	1492
Pittsburgh, Pennsylvania (C)	467	202	402	5095	4629	4898
Pittsfield, Mass. (A)	761	555	690	7493	6854	7165
Pocatello, Idaho (A)	555	710	561	6561	7342	6523
Portland, Maine (A)	743	629	693	7339	6698	7099
Portland, Oregon (C)	309	517	347	4157	4045	3847
Providence, Rhode Island (A)	625	481	570	5990	5448	5783
Pueblo, Colorado (A)	473	377	456	5408	5158	5479
Raleigh, North Carolina (A)	275	109	172	3677	3372	3046
Rapid City, South Dakota (A)	774	451	615	7334	6452	6974
Reading, Pennsylvania (C)	465	277	411	5113	4711	4921
Red Bluff, California (A)	179	355	177	2574	2970	2495
Reno, Nevada (A)	556	702	519	5612	6058	5465
Richmond, Virginia (A)	323	155	271	4106	3805	3889
Rochester, New York (A)	677	420	615	6780	6147	6477
Roswell, New Mexico (A)	222	149	185	3430	3381	3396
Sacramento, California (C)	189	308	196	2352	2863	2510
St. Joseph, Missouri (A)	444	157	297	5703	5001	4591
St. Louis, Missouri (C)	336	88	270	4574	4087	4368
Salt Lake City, Utah (A)	446	572	453	5388	6132	5552
San Antonio, Texas (A)	21	14	34	1456	1227	1579
San Diego, California (A)	182	158	151	1452	1223	1416
Sandusky, Ohio (C)	530	254	513	5825	5173	5601
San Francisco, California (C)	310	374	279	2443	2488	2275
Sault Ste. Marie, Michigan (A)	902	611	846	8507	7989	8517
Savannah, Georgia (A)	102	40	43	2005	2020	1710
Scranton, Pennsylvania (A)	602	362	516	6427	5612	5798
Seattle, Washington (C)	378	525	396	4504	4123	3991
Sheridan, Wyoming (A)	738	629	645	7632	7004	7287
Shreveport, Louisiana (A)	112	34	61	2190	2042	2117
Sioux City, Iowa (A)	587	220	474	7253	6176	6705
Spokane, Washington (A)	448	704	561	6742	6539	6331
Springfield, Illinois (A)	464	167	350	5623	4995	5084
Springfield, Missouri (A)	383	140	295	4741	4217	4551
Syracuse, New York (A)	656	400	570	6786	6161	6207
Tacoma, Washington (C)	380	526	435	4589	4287	4313
Toledo, Ohio (A)	575	288	555	6413	5595	6077
Topeka, Kansas (C)	395	129	295	5190	4530	4794
Trenton, New Jersey (C)	476	322	429	5115	4740	4924
Tulsa, Oklahoma (A)	245	88	173	3736	3186	3540
Utica, New York (O)	687	445	588**	7024	6593	6543**
Valentine, Nebraska (A)	751	375	543	7660	6405	6683
Walla Walla, Washington (C)	288	503	338	5177	4772	4639
Washington, D. C. (C)	335	197	314	4299	4013	4178
Wichita, Kansas (A)	379	147	280	4839	4189	4463
Williston, North Dakota (C)	815	529	663	9397	7876	8499
Winnemucca, Nevada (A)	549	709	546	5975	6786	5942
Yakima, Washington (A)	361	631	408	6429	5797	5580

For footnotes, see page 136.

INSULATION news from L·O·F GLASS FIBERS COMPANY



Wayne Johnson, of Johnson Insulation Company, used Super·Fine to insulate ducts for the Northwood Shopping Center in Royal Oak, Michigan. He found Super·Fine lightweight, easy to handle and cut—yet so strong it could be pulled between the ducts and walls without tearing.

Super·Fine's low installation cost means big business for contractors!

Fast installation combined with high insulating efficiency can clinch the contract for you.

Super·Fine's millions of fine glass fibers form countless dead air cells which provide highly efficient insulation. It is pleasant to handle—fast and easy to apply. It cuts readily with an ordinary knife, needs no special measuring or fitting, can quickly be wrapped around ducts and supporting hangers. Contractors find that workmen can apply more Super·Fine per day than other types of insulation.

You save on storage space, too, because Super·Fine comes in compressed rolls up to 72" wide, in all standard thicknesses and roll lengths. They take up less space, yet the insulation springs back to full thickness when unrolled.

There's big business ahead for you when you discover how Super·Fine can help you save on duct-application costs. Check your Yellow Pages for the nearest distributor or write: L·O·F Glass Fibers Company, Dept. 63-66, 1810 Madison Avenue, Toledo 1, Ohio.

LOF GLASS FIBERS
SUPER-FINE INSULATION

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO

Makers of glass fibers by the exclusive "Electronic-Extrusion" process

BOOK REVIEWS

Publications abstracted in this department should be ordered direct from publisher.

WATER-COOLING STANDARD

A new standard for Water-Cooling Towers for use with Air-Conditioning and Refrigeration Equipment is issued by Air-Conditioning and Refrigeration Institute. Known as ARI Standard 910-55, its purpose is to establish minimum requirements for design and construction of prefabricated natural-draft and factory-assembled, mechanical-draft, water-cooling towers for use with air conditioning and refrigeration equipment. It covers prefabricated natural-draft water-cooling towers and mechanical-draft water-cooling towers which are factory assembled into sections by the manufacturer.

The new standard defines the following types of water-cooling towers: Natural-draft, mechanical-draft, induced-draft, forced-draft, spray-draft, spray-filled, deck-filled, spray-deck, and packed. It also explains circulating water, cooling range, approach, drift, blow-down, make-up and total heat dissipation.

Components to be included as standard equipment are outlined as well as rating and performance and necessary published data.

Architects, consulting engineers and others will find that this new Standard provides a great deal of helpful information on water-cooling towers for use in connection with the purchase and specifications for this type of equipment.

Water-Cooling Towers for Use with Air Conditioning and Refrigeration Equipment, Standard 910-55. Published by Air-Conditioning and Refrigeration Institute, 1346 Connecticut Avenue, N. W., Washington, D. C. Copies free on request.

MANUAL ON INDUSTRIAL ENVIRONMENT

A new book on ventilation is Engineering Manual for Control of In-Plant Environment in Foundries, published by American Foundrymen's Society. It focuses attention on health, ventilation and comfort consideration in both large and small plants. Consequently, this book should have widespread interest in industry in general.

Prepared as a project in the AFS Safety, Hygiene and Air Pollution Control program, the book contains both the general background information and specific design data for making foundries a better place to work. Materials and processes that influence health, ventilation and comfort are discussed and their characteristics are identified. Ventilating systems are described generally and then specifically with data furnished for the design of exhaust hoods and exhaust systems.

Particular problems in foundry operations are discussed and remedies are given in chapters that cover sand handling, molding and core making, melting and pouring, radiation, cleaning room, welding, woodworking and dust and fume collectors.

Maintenance and testing, required to keep the ventilation and dust collecting system in effective operation, are described and recommendations for inspection schedules and procedures are given. Good housekeeping is discussed as a basic element in the dust control program and as a factor in reducing occupational disease and accidents.

Engineering Manual for Control of In-Plant Environment in Foundries, published by American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, Ill. 8½ x 11-inch, casebound, 152 pages, including 221 figures, 25 tables and numerous equations. Priced at $6 to members of the American Foundrymen's Society and $7.75 to non-members.

PLANT OPERATORS' MANUAL

A book for steam engineers, plant mechanics, and other power services personnel on how to maintain and operate their equipment, gives methods and pointers which will help them not only in their daily work but also in future upgrading and license examinations. A major feature of the book is its sequence illustrations, with each operation shown step-by-step in photographs or line drawings.

Boilers, steam engines, turbines, diesel engines, pumps, compressors, and similar equipment are covered. A wide range of practical materials is provided, covering such jobs as setting valves of a steam engine, charging a Freon compressor, overhauling a bearing, and timing and setting diesel engine valves.

The author, Steve Elonka, is Associate Editor of Power Magazine. He is a licensed marine engineer (steam) and holds a license as regular instructor (vocational school) with the New York City Board of Education.

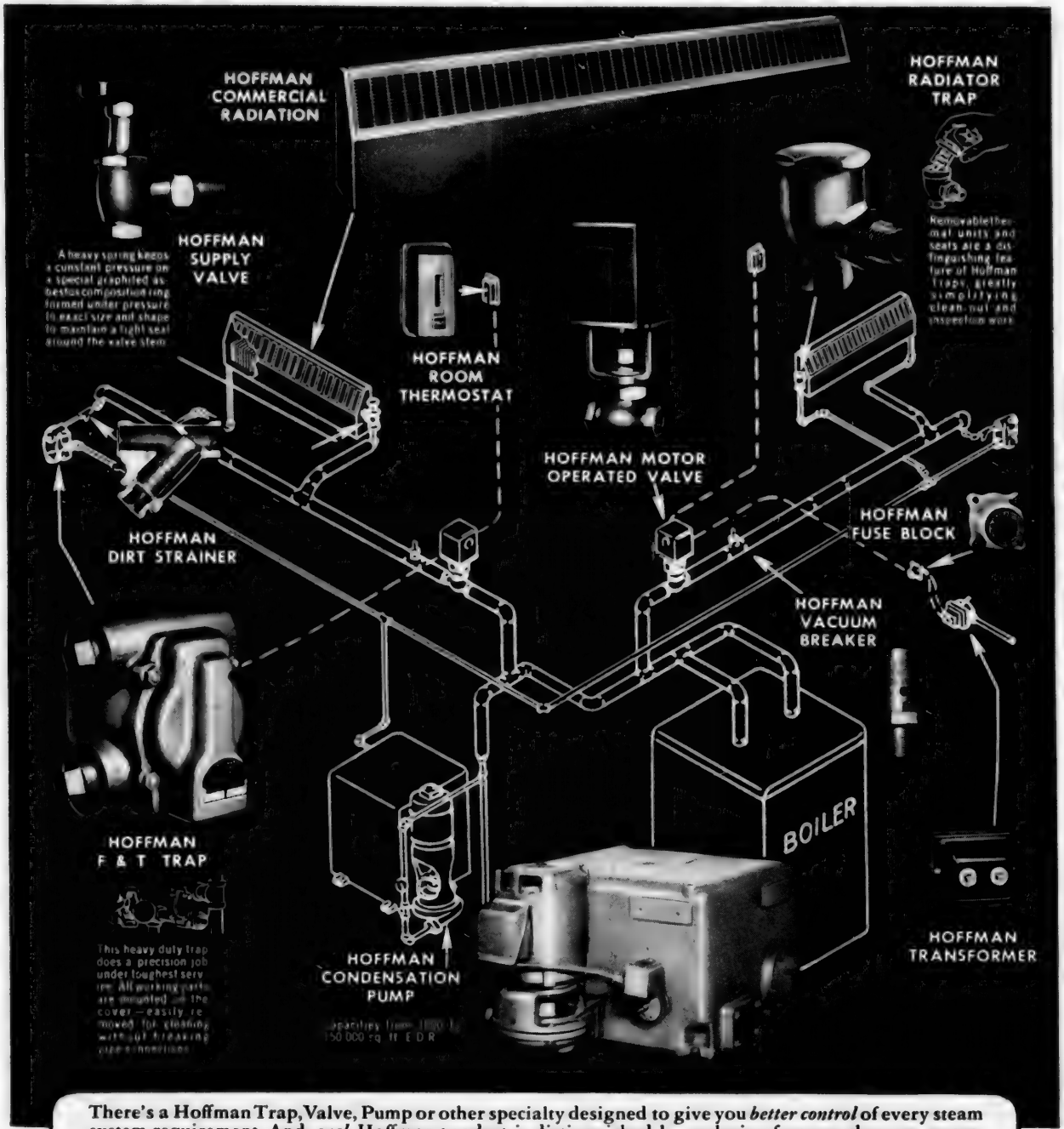
Plant Operators' Manual, by Stephen Elonka. 292 pages. Profusely illustrated. Published by McGraw-Hill Book Co., 327 W. 41st St., New York, N. Y. Price $5.00.

• • •

HOME AIR CONDITIONING—A 276 page, standard size book by Gerald John Stout of the University of Florida and apparently intended primarily for laymen and other non-technical readers and explaining the fundamentals of home cooling. Published by D. Van Nostrand Co., Inc., 257 Fourth Ave., New York 10, N. Y. Price, $5.95.

NATURAL GAS—The moisture contents of natural gases are important factors in the design and operation of equipment involved in natural gas production, processing and transmission. Prevention of hydrate formation and liquid water deposition in pipelines is ordinarily accomplished by dehydration, and the design and operation of dehydration equipment require accurate knowledge of the equilibrium moisture contents of the gases in question. Experimental measurements of the moisture contents of methane, propane, nitrogen, a methane-propane mixture, two methane-butane mixtures, a methane-pentane mixture, and nitrogen-free and high-nitrogen (14.8%) natural gases, at 220 deg and in the 1000-10,000 psi pressure range, and a newly-developed correlation for determining the equilibrium moisture content of any natural gas, are presented in IGT Research Bulletin No. 8, "Equilibrium Moisture Content of Natural Gases," by R. F. Bukacek. The book, priced at $3, is published by Institute of Gas Technology, Technology Center, Chicago 16, Ill., under sponsorship of an AGA committee.

HOFFMAN COMPLETE LINE OF *STEAM SYSTEM CONTROLS*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A heavy spring keeps a constant pressure on a special graphited asbestos composition ring formed under pressure to exact size and shape to maintain a tight seat around the valve stem
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Removable thermal units and seats are a distinguishing feature of Hoffman traps, greatly simplifying clean-out and inspection work
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Capacities from 1000 to 150,000 sq. ft. E D R
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There's a Hoffman Trap, Valve, Pump or other specialty designed to give you *better control* of every steam system requirement. And, *each* Hoffman product is distinguished by exclusive features that assure customer satisfaction, long, care-free service. *It's the* COMPLETE, *tested, quality line* backed by a dependable, single source of supply and responsibility. *Yet Hoffman Products cost no more than the ordinary kind—and pay their way with the fuel they save.* To avoid delays—order now from your wholesaler of heating and plumbing supplies. Catalogs available on all items.

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Makers of Vapor, Trap, Hot Water Heating Systems, Vacuum and Condensation Pumps. Sold by Leading Wholesalers of Heating and Plumbing Equipment

NEWS OF THE MONTH

PLANE CRASH

kills six Crane Co. executives in Indiana. Men were on way to HPACCNA convention in Louisville, Ky.

Six executives of Crane Company and two crew members were killed on May 15 when a twin-engine company plane crashed on an Indiana farm while attempting an emergency landing.

• **IDENTIFIED BY COMPANY.**—Enroute to Louisville, Ky., to attend a convention of the Heating, Piping and Air Conditioning Contractors' National Association, the six men were identified by the company as: J. A. McMurry, director of branches; James A. Dwyer, vice president of industrial sales; George L. Erwin, Jr., vice president of heating sales; Charles E. Towner, assistant to the heating sales vice president; and Fred J. Wilkey, Jr., a special representative of the industrial sales division.

Randy Mulherin, the pilot, and his son-in-law Robert Robinette, the co-pilot, were also killed in the crash.

The plane barely missed a farm house before it clipped the top of the trees and plunged nose-down into an open field surrounded by several houses. It literally buried itself in mud. Removal of the bodies took almost two hours.

COIL MANUFACTURER

installs own copper mill and facilities to make tube for an expanding, integrated production operation.

With the installation of its own copper mill, Halstead & Mitchell becomes one of the nation's most completely integrated manufacturers in the air conditioning and refrigeration industry, according to Byron Halstead, senior partner of the Pittsburgh, Pa., company.

Overall view of the copper mill. Two draw benches shown are capable of producing 2,600,000 lineal feet of tubing per month.

Steam cleaning of condensers for removal of impurities prior to tests and dehydration. Rack handles condensers simultaneously.

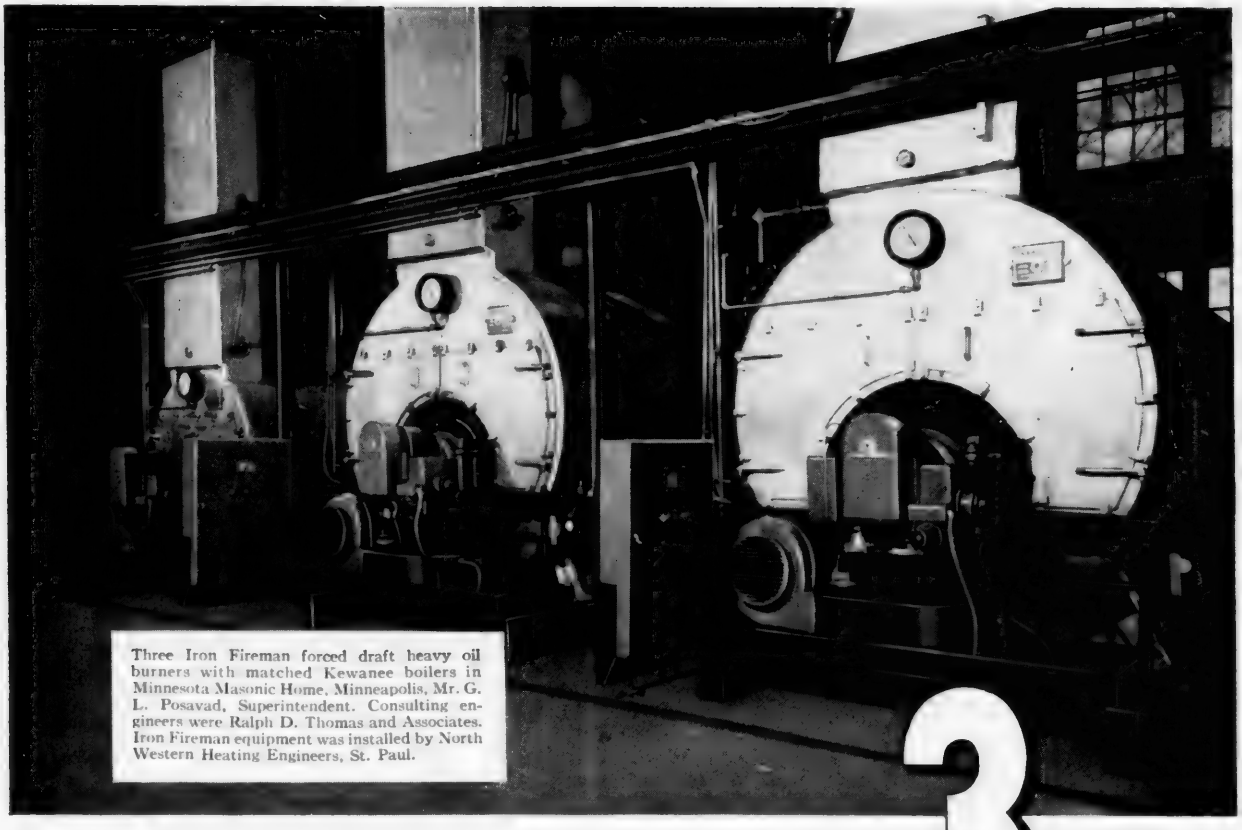
• **FACILITIES.**—Halstead & Mitchell manufactures water-cooled condensers, remote air-cooled condensers, and other products which make it highly dependent upon the availability of copper tube. Installation of a new extrusion press, draw benches, annealing facilities, and auxiliary equipment raises the company's production capacity for processing copper tube and brass shapes from 4 to 30 million pounds per year.

• **CAPACITY.**—So extensive is the tooling that today the company can turn out 2000 water-cooled, double-tube, counterflow, cleanable condensers each day. This is enough to take care of the present needs of the whole world in less than half a year.

For the manufacture of cooling towers, the firm has also installed tooling designed for a greatly expanded future. Present plant capacity, for instance, would be

(*Continued on page* 144)

One of the draw benches in high speed operation draws three tubes simultaneously from 1⅛-in size tubing down to ½-in.



Three Iron Fireman forced draft heavy oil burners with matched Kewanee boilers in Minnesota Masonic Home, Minneapolis, Mr. G. L. Posavad, Superintendent. Consulting engineers were Ralph D. Thomas and Associates. Iron Fireman equipment was installed by North Western Heating Engineers, St. Paul.

Why it paid to split this steam plant 3 ways

Heating engineer explains why he used three Iron Fireman firing units with matched Scotch boilers in Minnesota Masonic Home

Steam costs were getting out of hand. Should the old steam plant be modernized, or replaced?

After careful analysis of all possible alternatives, a new steam plant was recommended by Mr. A. C. Hunter, president of the engineering firm of Ralph D. Thomas and Associates. This involved replacement of three high pressure HRT boilers, automatic firing equipment, surge tank, feed water heater and all other accessories.

The new plant was designed for low pressure operation, using three boiler-burner units with Iron Fireman forced draft oil burners, in which boilers and burners are engineered as a single integrated unit. Says Mr. Hunter, "Boiler sizes were based on a small unit for summer operation, a large unit for normal winter load, a large unit for standby, and operation of any two for winter peaks." The new plant provides an increase of nearly 70 per cent in rated boiler capacity to take care of future needs for heating, kitchen, water heating and infirmary.

Even with this substantially larger plant, Mr. Hunter's studies showed that the savings in fuel, maintenance and operating costs will return the entire investment in 7 years.

IRON FIREMAN FORCED DRAFT BURNERS

Each Iron Fireman firing unit is a complete combustion system, consisting of burner, forced draft air supply, fuel system and control panel. All elements are assembled, wired and tested at the factory and mounted on a single base ready to attach to the boiler front. The unit can be installed with a matched Titusville or Kewanee Scotch boiler designed specifically for this burner, or in any other type of boiler.

FOR GAS, OIL OR GAS-OIL COMBINATION

The Iron Fireman forced draft burner is available for either oil or gas, or in a dual-fuel combination unit in which fuels can be shifted instantly with no break in operation. Any grade of oil can be used, from lightest to heaviest, without special adjustment. Fires natural gas (high or low pressure), manufactured, mixed, or bottled gas. Firing unit adaptable to any type of boiler.

Send coupon for further information.

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Automatic Firing Equipment for Heating, Processing and Power

IRON FIREMAN MANUFACTURING CO.
3037 W. 106th Street, Cleveland, Ohio.
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Please send technical information and specifications on Iron Fireman Forced Draft firing systems.

Name_____

Firm_____

Address_____

City_____ State_____

COIL MANUFACTURER

(*Continued from page* 142)

sufficient today to turn out in one year a volume of towers equivalent to all those made by the twenty-three leading manufacturers in 1955.

• **EXPANSION.**—Future expansion is planned at the same rate, according to Mr. Halstead. "In order to exceed the pace of the air conditioning and refrigeration industry, our program calls for a step-up of three times within the next few years," he stated.

Today, the company's Zelienople, Pa., plant covers 135,000 sq ft, and land has been acquired for an additional 250,000 sq ft of production space.

• **HISTORY.**—Halstead & Mitchell was founded in 1936 as an outgrowth of the Welsbach Company, Gloucester, N. J. As part of a diversification program, Welsbach entered the refrigeration field in 1927, manufacturing a line of high side, low side, commercial and residential refrigeration systems.

Byron Halstead came to Welsbach from Frigidaire in January, 1928, starting as commercial refrigeration sales manager of the Pittsburgh factory branch of the company. Miss Caroline J. Mitchell at that time served as manager of the Pittsburgh office.

Two other partners joined the business shortly after its formation; Fred E. Halstead became a partner in 1938, and William E. Rapp, in 1940.

The company purchased its first building for manufacturing in 1944 in Pittsburgh. The building involved some 6000 ft of manufacturing floor space. In 1947 the company moved its manufacturing operations into a 10,000 sq ft plant in Zelienople.

SPECIFICATION WRITING

for commercial and industrial oil burning will be a feature of OHI convention in New York, June 11-14.

The program has been completed, and everything is in readiness for the 34th Annual Convention of Oil-Heat Institute of America and space has just about been sold out for the concurrent Oil Heat and Air Conditioning Exposition to be held in New York June 11-15. On each of these days the Exposition will be open from 1 p.m. until 9 p.m., except on Friday when the exposition will close at 6 p.m. Meetings of the convention end Thursday.

The Exposition will be held in New York's new Coliseum which has basement parking facilities for 850 cars; the Coliseum is easily reached by buses and several subways.

A feature of the convention will be a symposium on commercial and industrial oil burners and intended for specification writers. The moderator will be C. H. Pesterfield, technical secretary of OHI.

Convention headquarters will be in the Park-Sheraton hotel where all convention meetings will be held except the Annual OHI Luncheon, which will be held at the Sheraton-Astor Hotel, at Times Square. The program follows:

Monday, June 11

Time	*Function*	*Room*
11:00 a.m.	Annual OHI Meeting	Tropical
1:00 p.m.	Annual Meeting Accessory Div.	Park & Sheraton
1:00 p.m.	Annual Meeting Technical Div.	French
1:00 p.m.	Annual Meeting Distribution Div.	Tropical
1:00 p.m.	Commercial-Industrial Engineering Committee	Towers (27th Fl.)

Tuesday, June 12

10:00 a.m.	Engineering-Technical Conference	Towers (27th Fl.)
10:30 a.m.	Domestic Equipment and Accessories Conference	Towers (28th Fl.)
12:15 p.m.	New Member Party	Park & Sheraton

Wednesday, June 13

9:30 a.m. Dealer Management Conference — Ballroom

Round Table Discussions with experts as discussion leaders, covering radio communications, tank failures, credit and collections, service contracts, service management, automatic deliveries, promotion and advertising, gas competition, sales training and organization, selling the builder, mechanization of office procedures, truck operator training, budget plans with life insurance, degree days, selling oil heating equipment, and increasing truck operator efficiency. At 11 a.m., a premiere showing of technical training film strip cooperatively produced by nozzle manufacturers belonging to OHI. At 11:40 a.m., a premiere showing of color TV film, "Housewarming Party." This will be the first showing of OHI's national promotional effort for automotive oil heating. This film will be scheduled to appear on approximately 300 TV stations and prints in black and white, or color, will be available at moderate cost for showing by local chapters and groups. T. R. Loizeaux, Sr. will be general chairman.

10:30 a.m. Commercial-Industrial Symposium — Tropical

(Designed for specification writers)

Codes and Ordinances, C. H. Pesterfield, Moderator

Handling and Burning Today's C-1 Oils, G. W. Bohn, Preferred Utilities

General and Specific Specifications for C-1 Oil Burning Equipment, Joseph Diehm of Voorhees, Walker, Smith and Smith, and William Cleland, of Seelye, Stevenson, Value and Knecht

Construction Specifications and Their Relation to Professional Ethics, Kenneth M. Wilson of E. F. Klingler and Associates, Inc.

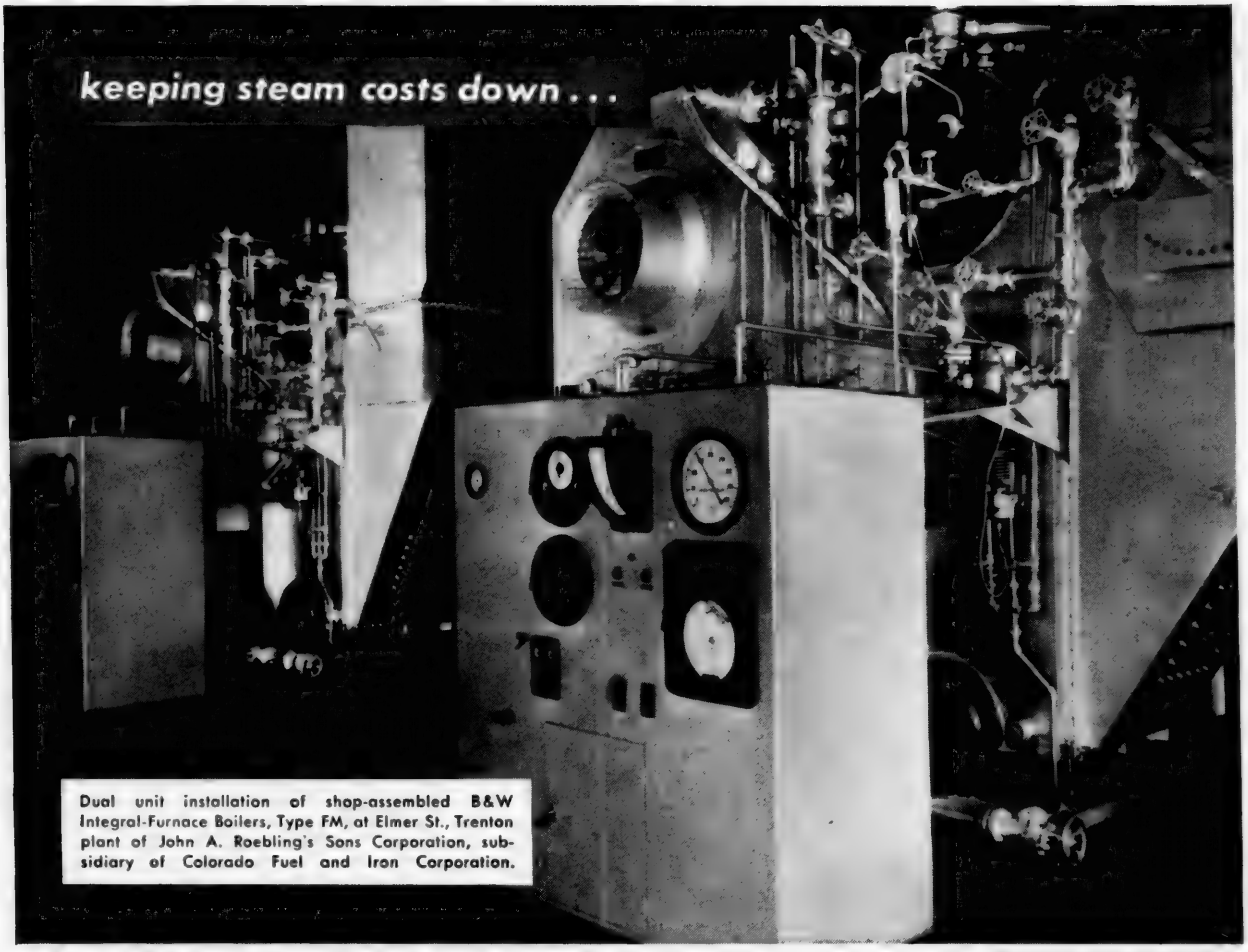
Buffet and cocktails at 12:30 p.m.

Thursday, June 14

9:30 a.m. Dealer-Management Conference — Ballroom

A premiere showing of the 42 min. color film strip, "Breakthrough For Profit." This film, produced for the Institute by Burroughs Corporation, tells the story of four heating oil dealers of varying sizes who achieved considerable reduction in operating costs through the mechanization of office procedures. At 10:30 a.m., an Air-Conditioning Panel. This panel, which will include Herb Spade and Harry Schwindt, two dealers who have successfully gone into the air conditioning business, E. A. Scott, Jr., and representatives from two large air-conditioning equipment manufacturers, will provide important and practical information to oil-heating dealers who are planning to enter this rapidly growing field. At 11:30 a.m., the feature speaker, Allen J. Johnson, whose topic will be Natural

(*News continued on page* 146)



Dual unit installation of shop-assembled B&W Integral-Furnace Boilers, Type FM, at Elmer St., Trenton plant of John A. Roebling's Sons Corporation, subsidiary of Colorado Fuel and Iron Corporation.

with Two More B&W FM Boilers *at* ROEBLING

A subsidiary of The Colorado Fuel and Iron Corporation

When John A. Roebling's Sons chose two B&W Integral-Furnace Boilers, Type FM, for their Elmer Street Plant in Trenton, N. J., they acted with the assurance born of experience. Nearly two years before, a single FM boiler had been put in operation at the company's Buckthorn Plant and its economical operation, dependability and B&W service were decisive factors in the selection of the additional FM units, which have been in service since October 1953.

Each of these compact, automatically controlled B&W FM Boilers is oil-fired with a B&W Y-Jet oil burner and is designed to supply 28,000 lb of steam per hr at pressures of 235 psi. They combine the fuel saving, space saving, and other practical benefits of "package" steam with many of the cost-saving advantages inherent in big-boiler design, and the result is substantial overall economy.

Repeat orders for B&W Boilers are an old story at Roebling. Even before the first FM was installed, three B&W Integral-Furnace Boilers, Type FH, started the trend with performance that has, on the record, brought consistently large annual savings. And last year, Roebling placed two more FM units in service, a total of five in their various plants.

Like Roebling, many other companies including industrial plants, utilities, and other users have found the versatile, self-contained B&W FM Boiler most suitable for their steam requirements. Units having a total steam capacity of well over 11 million lb per hr are now in service or on order. The FM Boiler is available in standard sizes for loads to 40,000 lb per hr at steam pressures to 235 psi. Many are in operation at higher pressures and with moderate superheat. Write for Bulletin G-76C for a detailed description of this boiler. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

Consider these
COST SAVING FEATURES
in terms of your steam requirements

- Saves Erection Time and Cost
- Meets Wide Range of Service
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and/or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation

G-641

BABCOCK & WILCOX

BOILER DIVISION

(*Continued from page* 144)

Gas Competition. This speaker will have a valuable and effective message for all dealers who are facing a competitive battle with natural gas.

12:45 p.m. Doors open for the OHI Luncheon, Sheraton-Astor Hotel (at Times Square), Grand Ballroom Suite.

ARI MEETING

elects Lawler president. Speakers cite inflation curbs, industry's future, and new methods of distribution.

Matthew M. Lawler, vice president of Worthington Corp., Harrison, N. J., was elected president of the Air Conditioning and Refrigeration Institute at the annual ARI board of directors meeting in Hot Springs, Va.

He succeeds James Emmett, Jr., of Jas. P. Marsh Corp., Skokie, Ill. During the past year, Mr. Lawler was vice president of ARI and has served as treasurer of the organization. Lud Emde, president of Temprite Products Corp., Birmingham, Mich., was elected vice president of ARI, and C. E. Buchholzer, president of Airtemp Div., Chrysler Corp., was named treasurer.

Four newly-elected members of the ARI board of directors took office at the meeting. They were D. P. Barrett, general sales manager of Davison Chemical Co.; Rudy Berg, vice president of Copeland Refrigeration Corp.; Charles T. Lawson, executive vice president of Kelvinator; and D. R. Moerick, vice president of Controls Corporation of America. Mr. Lawler, newly-elected president, and Mr. Emde were also named as directors-at-large.

• **INFLATION CURB.**—In an address to the meeting, Dr. Jules Backman, professor of economics at New York University, told ARI members that "The recent rise in the discount rate by the Federal Reserve Board was a necessary move to curb the danger of inflation resulting from an excessive expansion of debt.

"Consumer credit, mortgage debt, and bank credit have been expanding at rates which cannot be sustained. This rate of credit increase, compared with the rise in gross national product and with the normal rate of increase, has resulted in pressure on prices."

Dr. Backman pointed out, "Despite the anticipated small budgetary surplus, a reduction in taxes would add to the inflationary pressures."

• **RISE IN INDUSTRIAL COOLING.**—The speaker stated, "The short and long term outlooks for the air conditioning industry are very bright. It faces a major period of expansion in volume as more rooms and more homes are air conditioned. The development of units to take care of year-round temperature control has provided an important stimulus to sales, and a rapidly-growing number of factories and offices have been discovering the very favorable impact on labor productivity of air conditioned space. Accordingly, sales to industrial users also will continue to rise sharply."

• **NEW SALES METHODS NEEDED.**—Speaking before the annual meeting, Eugene B. Mapel, vice president of Barrington Associates, New York management consultants, pointed out that "list prices are largely a myth and that many discount houses are now upgrading their service and methods of selling to compete with department stores and other dealers in appliances."

He recommended that management consider the discount house as a symptom of the need for revised methods of distribution rather than the cause of lower prices.

NEW HEAT PUMP DESIGN

eliminates need for auxiliary heating at peak loads when using low temperature outside air as source.

Something new in heat pump design which permits air at zero temperature to be used as a heat source for heating a building, without resorting to strip heaters for the peak load, is announced by York Corp., York, Pa. A heat pump of this design was installed in the new Heironimus Department Store in Roanoke, Va., and will be placed in the office building of Ballinger Co., Philadelphia, Pa.

• **PRINCIPLE.**—The principle is to use two stages of compression during the heating cycle. In that way there is no difficulty in using outside air at below freezing temperature as the supply for the heat pump, and there is no need for strip heaters during the peak heating period. During summer operation when cooling is required, an automatic change-over converts operation from two-stage to single stage to obtain the best conditions. Single stage compression is adequate for heating when temperatures outside air conditions prevail.

Temperature control panel and motor control center.

Heat removed by the refrigerant from the outside air can be used to produce hot water which is circulated throughout the building in an indirect system, or the hot refrigerant can be used directly in coils to provide forced warm air heating.

York engineers claim that this new development will do away with the use of well water or ground coils to have a heat source with a higher temperature than outside air during the winter months.

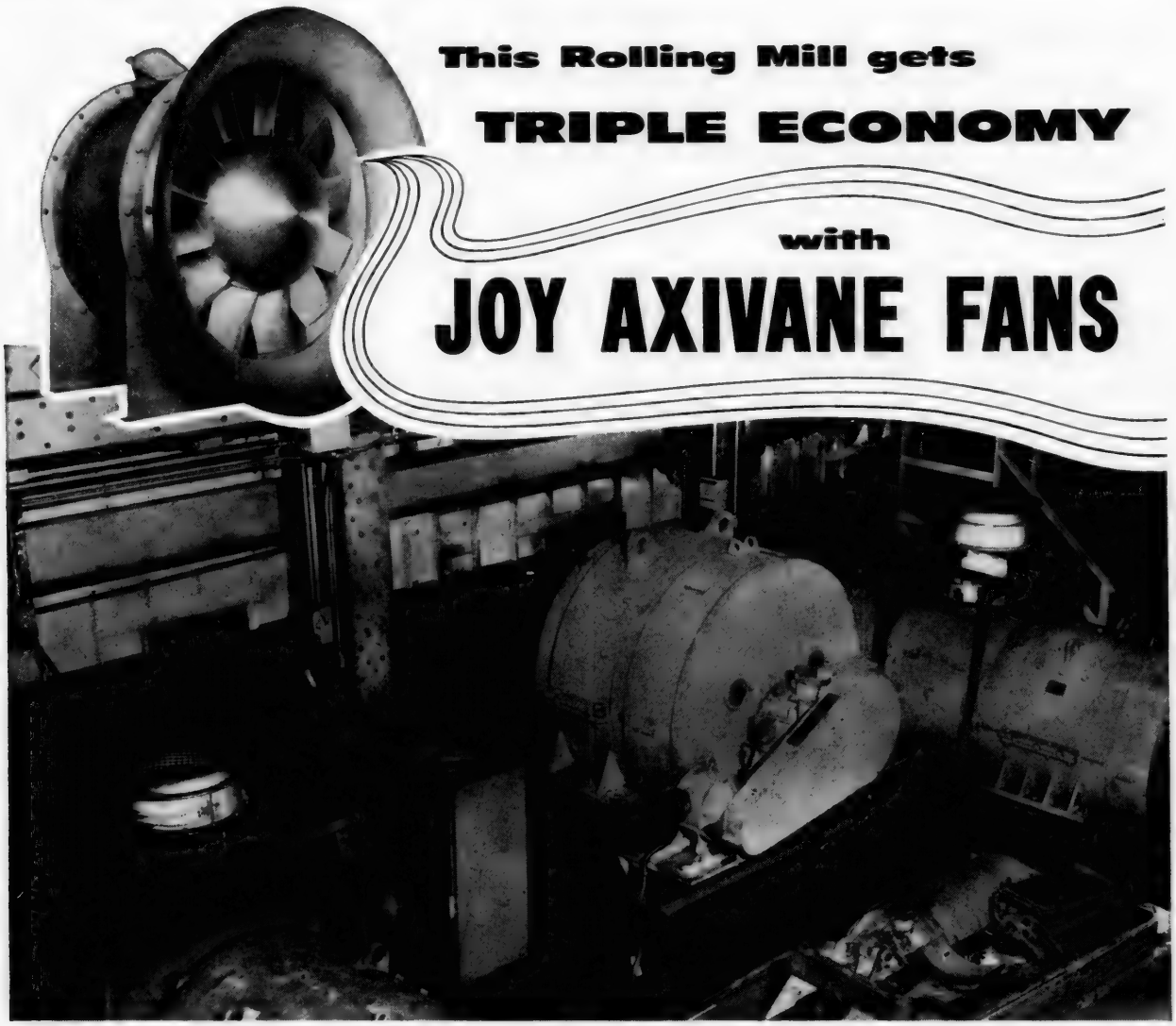
• **DEVELOPMENTS.**—Although the two present installations of this system are in commercial buildings, it is the hope of York to have a packaged heat pump using two-stage operation, for residences in about a year. There is still the problem of fitting the equipment into a special package or cabinet.

This Rolling Mill gets

TRIPLE ECONOMY

with

JOY AXIVANE FANS



They Save POWER • LABOR • SPACE

A typical example of the adaptability of Joy *Axivane* Fans to unusual ventilating applications is this one in the motor room of one of America's largest rolling mills. An *Axivane* fan is mounted atop each motor housing . . . its job is to cool the windings and other important components of the drive motor.

Because of the in-line design of the Joy fans, no elaborate duct system was required . . . installation was considerably simplified. Because a Joy fan is actually built *around* its motor, power-loss from motor to fan is negligible. Space requirements, as shown above, are at the irreducible minimum.

Joy *Axivane* Fans will show you new standards in efficiency, compactness, quietness, and outstanding versatility. There are 136 models for volumes up to 200,000 CFM and pressures to 11″ wg. Get the full story by writing to **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Bulletin 93-40

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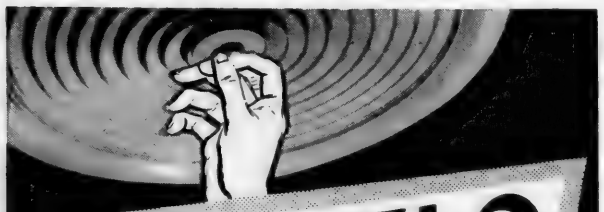
WORLD'S LARGEST MANUFACTURER OF VANEAXIAL-TYPE FANS



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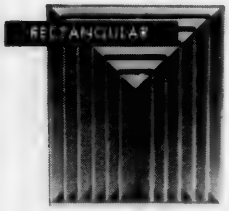
The Diffuser for Every Application

Here's the complete diffuser line with all extra features: built-in equalizing deflectors; easy to install; quick adjustment of air volume and diffusion pattern; simplified engineering; beautifully finished in any color baked enamel.

Let our sales engineers show you why Flexiflo is better for your jobs. But first — get the Flexiflo catalog.

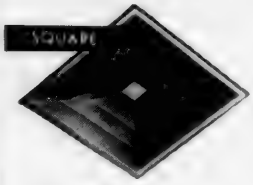
Type R, constant flow pattern regardless of volume adjustment.

Type V, fully adjustable air diffusion pattern and volume.



Type MP, for 1-, 2-, 3- or 4-way diffusion to accommodate any shaped area, 16 styles.

Type CH, adjustable for heating, ventilating and cooling.



Type H, adjustable volume, constant pattern and radius of diffusion.

Type S, side wall or ceiling, with Type R or V blades for heating or cooling.

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WHAT READERS SAY

Dry Wells

EDITOR, AIR CONDITIONING, HEATING AND VENTILATING:

In reference to the problem dealing with dry wells in the "What Would You Do" section, I submit the following for your consideration:

Dry wells are most successful in sandy soils or gravel; if the soil is relatively porous, generally satisfactory drainage is obtained. However, in a clay type of soil, the well will not drain and will fill up and overflow. After excavating, by setting off a charge of dynamite in the hole, a general loosening of the ground in the area may be obtained to increase the soil absorption characteristics. The rate of water dissipation in sandy soils is about twice the dissipation rate in relatively permeable non-clay soils.

The walls of the pit are lined with brick or concrete block with open joints (no mortar).

The pit should be below the frost line but above the elevation of the water table.

A "rule of thumb" used to size the rain leaders emptying into the dry well is based on a design rainfall and the roof area. For a pitched roof and an 8 inch per hour rainfall, one square inch of rain leader cross-sectional area will serve 160 to 200 sq ft of roof area.

Since the volume of the well required is so sensitive to soil characteristics, it is best found by experiment. After digging the pit, it is filled with a measured quantity of water, and the length of time required for drainage noted. The volume may be determined after the drainage rate is determined and the volume of water handled by the rain leaders is estimated for usual local rainfall conditions.

E. W. Jerger
Associated Professor,
Department of Mechanical Engineering
Notre Dame, Ind. *University of Notre Dame*

EDITOR, AIR CONDITIONING, HEATING AND VENTILATING:

We read the discussion on dry wells in the What Would You Do? department, April, 1956, issue and it occurs to me that you may be interested in a less expensive solution.

We have found in all plumbing layouts, it is more and more important to keep all costs at a minimum. With dry wells, to keep costs down but performance adequate, there are several factors to consider:

1. A cheap but adequate dry well design must be worked out such as illustrated in Fig. 1. Please read to the end of this letter before forming your opinion as this has been used for many years with satisfactory results.
2. Provide the overflow shown on each downspout. When a heavy rain occurs, all the ground around the building is covered with water. No matter how large the dry well, the average ground is quickly saturated, and the rest of the water runs out the overflow with less harmful results than soaking and softening up the lower levels of the soil.
3. Three small dry wells are better than one large well with expensive long runs of large pipe. It is best to have a small well for each downspout. This results in short piping runs.

(*Concluded on page* 150)

UNARCO

ROYAL-AIRE *a distinctive conditioner featuring UNARCO "pump-down" control system*

It is doubtful that any air conditioner can match the efficiency and beauty of the UNARCO ROYAL-AIRE. This all-new conditioner provides "just right" cooling comfort, adding distinction to *any* setting.

Oversize cooling coils . . . accessible, hermetic motor-compressor units... and the exclusive UNARCO "pump-down" control system, which prevents compressor damage... are but a few outstanding features of the ROYAL-AIRE line.

Available in five capacities (3 to 15-ton) the ROYAL-AIRE is *balance-engineered!* This insures full cooling capacities and quiet operation under all conditions, producing a pleasurable climate and atmosphere for any size room.

The ROYAL-AIRE is eminently suited to comfort-cool dining rooms, taverns, drug stores, clothing stores, and offices... to cool wherever the *ultimate* in efficiency and long life is desired. Address Heating & Cooling Division for descriptive literature.

Union Asbestos & Rubber Company
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UNARCO

the *finest* in heating and cooling products *at no extra cost*

CARNES recommends
***Alnor* VELOMETER**
for instant Air Flow readings

Like all major manufacturers of air diffusers, Carnes Manufacturing Corporation recommends the use of an Alnor Velometer when balancing an installation of its air diffusers, such as the Model EJ shown being tested above.

Carnes knows that you can measure *actual* air delivery—precisely and quickly—with the Alnor Velometer. Such accuracy assures design performance of every installation.

The Velometer is the only instantaneous, direct reading air velocity meter—accurate in all ranges, from high to low...compact, portable, easy to understand and use. Wide assortment of jets and fittings makes this precision instrument ideally suited for all air velocity measurement.

Take the recommendation of every major manufacturer of air diffusers—get an Alnor Velometer. You'll save time and money on the next installation you balance.

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City.....Zone....State.....

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

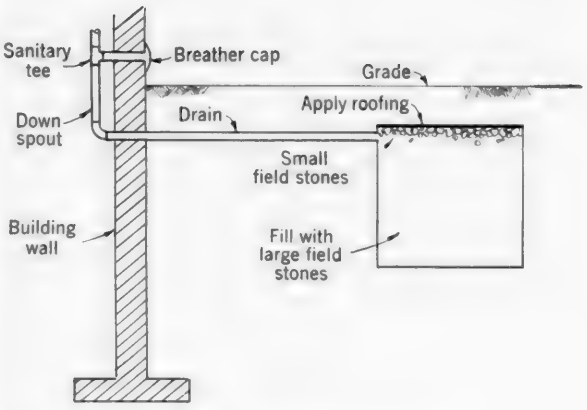


Fig. 1. Construction of dry well.

4. The purpose of a dry well is not to hold the maximum roof drainage, but to keep the grounds from having puddles after each small rain.

5. Sizing the dry well can be as follows and will be very adequate:

Size of Downspout, In. Dia.	Size of Dry Well, Dia. and Depth, Ft
3	2.5 by 3
4	4 by 4
5	5 by 5
8	6 by 5

These dry wells cost from $30 to $60 each. Hollow dry wells must have reinforced tops strong enough for heavy trucks, and in such cases, the cost is approximately ten times as much.

Len E. Rollins,
Rollins & Stone, Inc.
Mechanical Engineers
Denver, Colo.

Canadian Degree Days for April, 1956*

City	April		Cumulative	
	1956	Normal	1955-56	Normal
Calgary, Alta.	887	750	10287	8631
Charlottown, P. E. I.	901	858	7787	7727
Crescent Valley, B. C.	620	624	7744	7328
Edmonton, Alta. ...	873	780	10921	9369
Fort William, Ont. .	948	888	9573	9478
Grande Prairie, Alta.	884	822	11803	9617
Halifax, N. S.	801	768	6737	6902
London, Ont.	732	642	7148	6968
Medicine Hat, Alta..	762	606	9728	8194
Moncton, N. B. ...	868	798	8103	8094
Montreal, P. Q. ...	757	715	7950	8088
North Bay, Ont. ...	937	813	9191	8746
Ottawa, Ont.	783	726	8254	8364
Penticton, B. C. ...	479	507	6709	6073
Prince George, B. C.	783	738	10371	8506
Quebec City, P. Q...	839	849	8568	8848
Regina, Sask.	1037	816	11307	10457
St. John, N. B.	850	792	7861	7576
Saskatoon, Sask. ..	1011	725	11560	10081
Timmins, Ont.	1016	984	10214	10293
Toronto, Ont.	706	669	6631	6895
Vancouver, B. C. ..	476	498	5411	4977
Victoria, B. C.	479	504	5311	4569
Windsor, Ont.	637	582	6452	6454
Winnipeg, Man. ...	1047	822	10902	10444

*These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada.
The Department reports a slight revision in the figures for March, as published in last month's issue. Corrected figures are: Ottawa, Ont., 1317; Winnipeg, Man., 1601.

prove it to yourself!

...that this cast iron boiler is best for

horizontal rotary oil burners

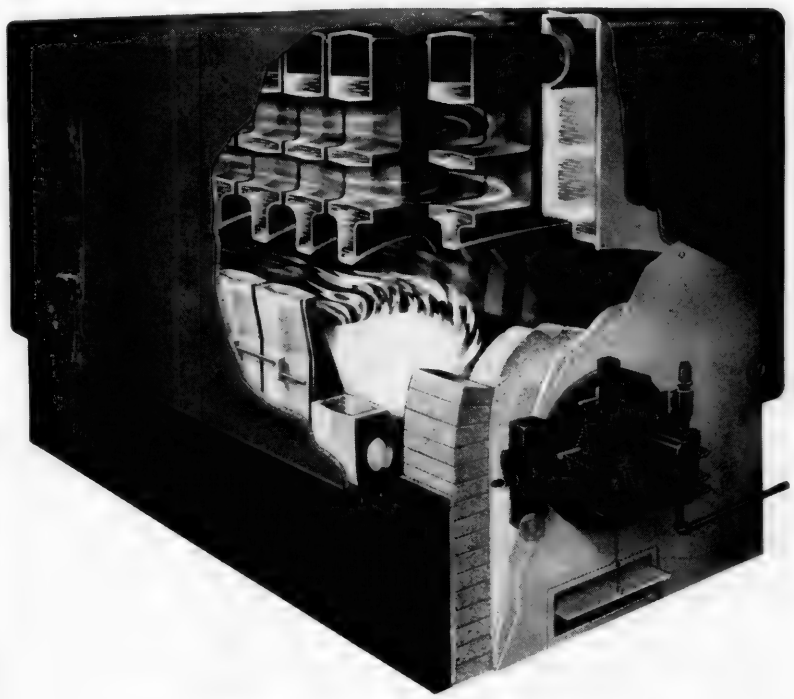
Weil-McLain "HR" Series Boilers are designed with one specific objective—*to most effectively develop the economies obtainable with horizontal rotary cup oil burners.* These boilers are constructed not only to provide the most favorable burning conditions, but also to efficiently absorb the intense heat generated by rotary burner flames.

Compare the "HR" with any boiler you choose...put a check in every space where it equals the "HR" Boiler. We believe you'll wind up with a surprising number of unchecked spaces.

- ☐ **1.** Designed in cooperation with and approved by leading makers of rotary oil burners.
- ☐ **2.** Steel front plate designed for easy, accurate burner mounting.
- ☐ **3.** Factory drawings furnished showing proper combustion chamber construction.
- ☐ **4.** Certified ratings for 150,000 BTU oil.
- ☐ **5.** Extra large combustion volume.
- ☐ **6.** High base to minimize foundation work.
- ☐ **7.** Low heat release per cu. ft.
- ☐ **8.** Greater primary heating surface.
- ☐ **9.** Balanced flue gas travel.
- ☐ **10.** Cast iron construction—highest resistance to corrosive effect of oils with high sulfur content—long life without expensive repairs.
- ☐ **11.** Short draw-rods for easier assembly.
- ☐ **12.** Rear access door for convenient build-up and servicing of combustion chamber.
- ☐ **13.** Lower building costs because of smaller boiler room.
- ☐ **14.** Additional capacities added at low cost.
- ☐ **15.** Easy cleaning because of large access doors.
- ☐ **16.** Enamelled steel jacket—fully insulated.

WEIL-McLAIN HR SERIES

CAST IRON BOILER



WEIL-McLAIN

For complete details write for Bulletin C-188

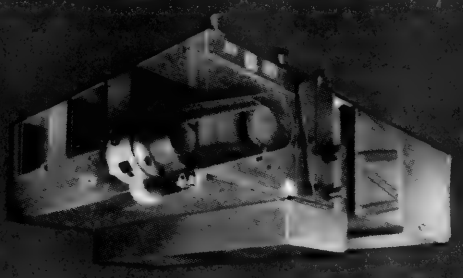
WEIL-McLAIN BOILERS-RADIATORS

WEIL-McLAIN COMPANY

MICHIGAN CITY, INDIANA

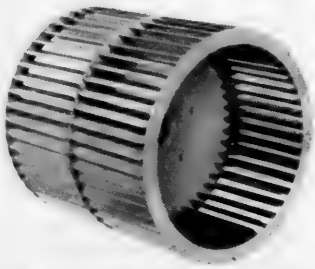
Address literature requests to Dept. BB-66

Carrier Heating and Ventilating Units...



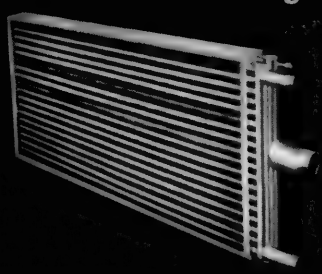
for civic, commercial and industrial buildings

now offer new Forward Curved fans...



for higher efficiency, quieter-than-ever operation

plus a choice of 72 heating coils!



six coil capacities in both distributing and U-bend coils for each casing size

New free 12-page catalog lists details, specifications, capacities.

CARRIER CORPORATION

306 S. Geddes St., Syracuse, New York

Carrier

I want to know more about the improved Carrier Heating and Ventilating Units. Please send me the new catalog.

Name _____

Firm _____

Address _____

City _____ Zone ____ State _____

COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available

PLUMBING AND HEATING EXPOSITION—1956 National Plumbing and Heating Exposition, in conjunction with the 74th meeting of the National Association of Plumbing Contractors, Inc., to be held in the Milwaukee Auditorium, Milwaukee, Wis. Secretary of the Association, 1016 20th, N. W., Washington, D. C. . . . . **JUNE 11-14, 1956.**

OIL-HEAT SHOW—21st National Oil-Heat and Air Conditioning Exposition, at the new Coliseum, New York, N. Y., to be held concurrently with the 34th Annual OHI Convention of the Oil-Heat Institute of America, with headquarters at the Park Sheraton Hotel, New York. R. H. L. Becker, managing director of the Institute, 500 Fifth Ave., New York 36, N. Y. . . . . **JUNE 11-16, 1956.**

ASME MEETING—Semi-annual meeting of The American Society of Mechanical Engineers, at the Hotel Statler, Cleveland, Ohio. Secretary of the Society, 29 W. 39th St., New York, N. Y. . . . . **JUNE 17-21, 1956.**

TESTING MATERIALS MEETING—59th annual meeting of the American Society for Testing Materials, at the Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary of the Society, 1916 Race St., Philadelphia 3, Pa. . . . . **JUNE 17-22, 1956.**

ASHAE MEETING—Semi-annual meeting of the American Society of Heating and Air-Conditioning Engineers, Inc., at the Shoreham Hotel, Washington, D. C. A. V. Hutchinson, secretary of the Society, 62 Worth St., New York 13, N. Y. . . . . **JUNE 18-20, 1956.**

INSTRUMENT SOCIETY EXHIBIT—11th annual Instrument-Automation Conference and Exhibit (International), of the Instrument Society of America, at the new Coliseum building, New York, N. Y. J. McCaffery, assistant executive secretary of the Society, 1319 Allegheny Ave., Pittsburgh 13, Pa. . . . . **SEPTEMBER 17-21, 1956.**

AGA CONVENTION—Annual convention of the American Gas Association, at the Auditorium, Atlantic City, N. J. Secretary of the Association, 420 Lexington Ave., New York 17, N. Y. . . . . **OCTOBER 15-17, 1956.**

ASA MEETING—38th annual meeting of the American Standards Association, in conjunction with the Seventh National Conference on Standards, at Hotel Roosevelt, New York, N. Y. Secretary of the Association, 70 E. 45th St., New York 17, N. Y. . . . . **OCTOBER 22-24, 1956.**

ASRE CONVENTION—Semi-annual meeting of the American Society of Refrigerating Engineers, at Hotel Statler, Boston, Mass. Secretary of the Society, 234 Fifth Ave., New York 1, N. Y. . . . . **NOVEMBER 25-28, 1956.**

ASME MEETING—Annual meeting of the American Society of Mechanical Engineers, Hotel Statler, New York, N. Y. Secretary of the Society, 29 W. 39th St., New York, N. Y. . . . . **NOVEMBER 25-30, 1956.**

POWER SHOW—The 22nd National Exposition of Power and Mechanical Engineering, under the auspices of the ASME, at the New York Coliseum, Columbus Circle, New York, N. Y. E. K. Stevens, International Exposition Co., 480 Lexington Ave., New York 17, N. Y. . . . . **NOVEMBER 26-30, 1956.**

CHEMICAL EXPOSITION—9th National Chemical Exposition of the American Chemical Society, in the Cleveland Public Auditorium, Cleveland, Ohio. Secretary of the Chicago Section of the Society, 86 E. Randolph St., Chicago, Ill. . . . . **NOVEMBER 27-30, 1956.**

ASHAE EXPOSITION—International Heating & Air-Conditioning Exposition, at the International Amphitheater, Chicago, Ill. E. K. Stevens, International Exposition Co., 480 Lexington Ave., New York 17, N. Y. Exposition held in conjunction with the 63rd annual meeting of the American Society of Heating and Air-Conditioning Engineers, Inc. A. V. Hutchinson, secretary of the Society, 62 Worth St., New York 13, N. Y. . . . . **FEBRUARY 25-MARCH 1, 1957.**

METALS CONGRESS AND EXPOSITION—10th Western Metal Congress and Exposition, sponsored by the American Society for Metals, and other technical groups, at the Pan-Pacific Auditorium and the Ambassador Hotel, Los Angeles, Calif. W. H. Eisenman, managing director of the Society, 7301 Euclid Ave., Cleveland 3, Ohio. . . . . **MARCH 25-29, 1957.**

GAMA MEETING—Annual meeting of the Gas Appliance Manufacturers Association, at The Greenbrier, White Sulphur Springs, West Va. H. Leigh Whitelaw, managing director of the Association, 60 E. 42nd St., New York, N. Y. . . . . **APRIL 8-10, 1957.**

AIRCOUSTAT SILENCES ALL FREQUENCIES IN THE AUDIO-FREQUENCY RANGE!
Resonators hold low-frequency sounds
Periodic internal structure dampens middle-frequency noise
Sound-absorbent materials suppress high frequencies

AIRCOUSTAT* Sound Traps eliminate air conditioning noise at 50% less cost

Acoustical Performance Guaranteed. Easy to Install. Pre-Engineered — No Design or Layout Headaches.

Revolutionary AIRCOUSTAT Sound Traps require no special tools for installation . . . reduce your labor costs and lower your installation time. Units fit any size or shape of duct. If AIRCOUSTAT fits *geometrically*, it fits *acoustically*.

AIRCOUSTAT is the most efficient method of sound-deadening you can provide your customers. A 7-foot AIRCOUSTAT unit suppresses as much sound as 100 feet of ordinary duct lining. AIRCOUSTAT eliminates all frequencies in the entire audio-frequency range, silences entire systems or selected outlets. Flow resistance and pressure drop are lower. 4 series cover applications ranging from general offices to recording studios.

Discover how AIRCOUSTAT Sound Traps can save you time and money . . . create greater customer satisfaction.

**Koppers Trade Mark*

KOPPERS **INDUSTRIAL SOUND CONTROL**

Engineered* Products Sold with *Service

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Gentlemen: Please send me a free copy of your booklet on AIRCOUSTAT Sound Traps.

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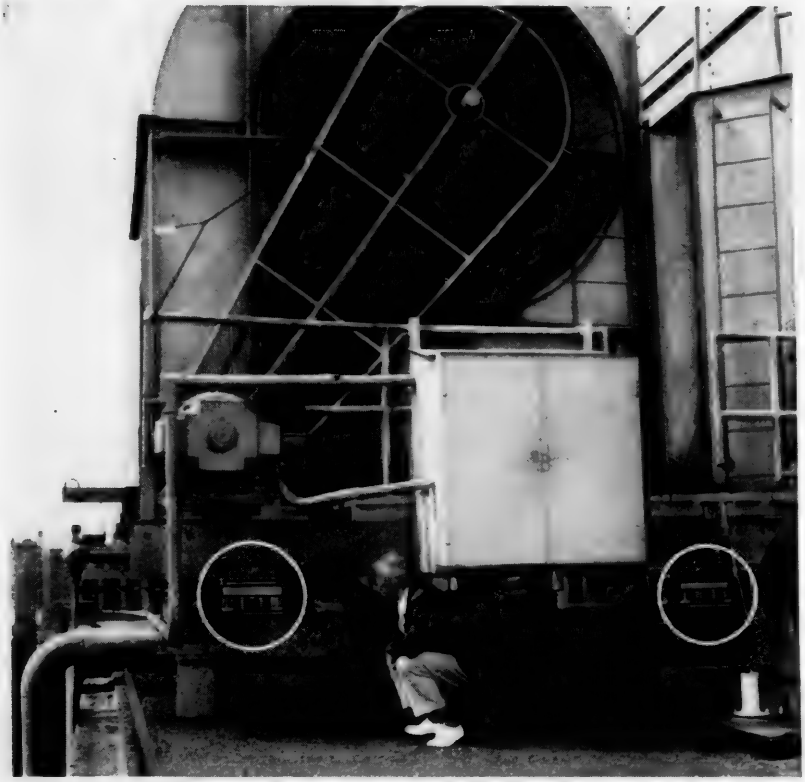
KORFUND
VIBRATION CONTROL



Means MORE ROOMS FOR RENT

The ability to utilize every inch of available space is sometimes the difference between profit and loss in building management.

The photo shows a fan installation on the roof of a famous hotel. Until the Korfund Steel-Spring Vibro-Isolators were installed, twenty rooms on the floor below could not be rented because of vibration. Even water standing in drinking glasses showed a decided side-to-side movement. The simple rubber pads installed previously just couldn't do the job.

Correcting faulty vibration control installations such as this, and recommending the right way the first time is made possible by experience. Korfund has more than a half-century of experience in the vibration control field. So when you have a problem, bring it to Korfund—you'll get impartial recommendations on media, whether it be springs, rubber, or cork, alone or in combination. Our experience will tell us which is best for you. And after all, there is no substitute for experience. Korfund can help you solve your vibration problem.

Write for a copy of the booklet "Air-Conditioning Goes Up in the World" which tells how to increase profits through vibration-free upper floor installations. Ask for Bulletin 32.

For specific recommendations, contact us or one of the 46 local Korfund offices. Look under "Korfund" in your local Telephone Directory or in Thomas' Register.

THE KORFUND CO., INC.

KORFUND VIBRATION CONTROL — SPRINGS — RUBBER — CORK

48-01E Thirty Second Place, Long Island City 1, N. Y.
In Canada: 510 Canal Bank, Ville St. Pierre, Montreal

NEW CATALOGS

Use the prepaid postcard on page 105 for securing your copies of catalogs described in this department.

DRAFT INDUCER—A new bulletin, No. I-56, on its line of draft inducers for heating boilers and power plants, is issued by L. J. Wing Mfg. Co., Linden, N. J. New features are listed, including interchangeable inlet panels and fan drive through V-belt with motor mounted on a spring base to maintain automatically the correct belt tension. Shaft and bearings are rigidly mounted at the factory and the unique air cooling system keeps fan bearings within a few degrees of ambient temperature, while sealed bearing require no additional lubrication. Fan, shaft, bearings and motor constitute a sub-assembly, easily removable from the casing for inspection or servicing. Bulletin contains a simple selection table for most heating plant installations and two pages of selection curves for use in selecting draft inducers for power plants. ----------**Item 77**

FITTINGS CATALOG—A supplement, No. 2, to Catalog No. B-154 on fittings and carriers for toilet fixtures is released by Blake Div., Hoffman Speciality Mfg. Corp., Indianapolis, Ind. The applications, descriptions, ordering information, and alterations for each item in the line are given in the catalog supplement. ---------**Item 78**

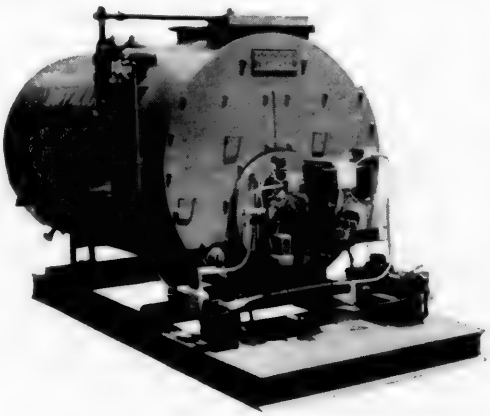
FAN BULLETIN—Bulletin A-113 describing a controllable pitch heat exchanger fan, is available from Hartzell Propeller Fan Co., Piqua, Ohio. The bulletin explains how variable air delivery is accomplished by the variation in blade pitch setting of the fan. ----------**Item 79**

VALVE CATALOG—A 20-page catalog illustrating and listing the specifications of magnetic and motorized valves for use with air, water, gas, steam, oil, and refrigerants is offered by The Mercoid Corp., Chicago, Ill. The catalog is designated No. V-55. ----------**Item 80**

DUST CONTROL BULLETIN—A product bulletin (270-E3) that describes different designs of exhaust hoods for dust control in the woodworking industry is released by the American Air Filter Co., Inc., Louisville, Ky. The bulletin has been prepared to show how more effective exhaust hoods have been designed for the many operations common to the woodworking industry. It is the third manual to be compiled from a series of articles entitled Scrapbook of Exhausting Ventilation, written by John M. Kane, manager of the company's Dust Control Products. ----**Item 81**

AIR CONDITIONING CATALOG—Catalog No. AC 429, published by National-U. S. Radiator Corp., Johnstown, Pa., describes self-contained, highboy air conditioning units in sizes from 2 to 15 tons. The specifications of the units, their dimensions, and performance data are tabulated in the catalog. ----------**Item 82**

(*Continued on page* 156)



BISON

SUPER SCOT BOILERS

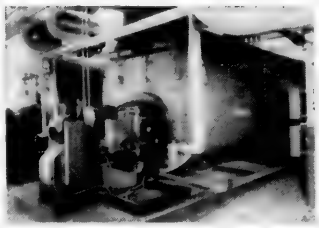
for packaged heating units

To the best in the century-old Scotch Boiler with its tried-and-true two-pass design, BISON Super Scot Low-Pressure Boilers offer a number of advantages made possible by their exclusive features.

Per unit of heating surface, Super Scot Boilers are bigger. They have a larger furnace, more steam space and water content. The area directly exposed to the radiant heat of combustion is a greater percentage of the total heating surface. Certified ratings are moderate but extra loads can be handled with larger burners.

Results—smokeless combustion, extra capacity for peak loads, lower maintenance, longer life and less cost of steam generated.

Consult F & T also for high-pressure boilers.



Two BISON Super Scot Low-Pressure Boilers at Sylvania Electric Products, Inc., Batavia, N. Y. Engineers and General Contractors, Siegfried Construction Co., Inc., Buffalo, N. Y.; Heating Contractors, Joseph Davis, Inc., Buffalo, N. Y.

FARRAR & TREFTS DIVISION
ADSCO INDUSTRIES, INC.
20 MILBURN ST. BUFFALO 12, N. Y.

BRIGHT IDEA! COMBINE LIGHT FIXTURES WITH KNO-DRAFT AIR DIFFUSERS

Shown is the two-story main lounge of Men's Residence Hall at the University of Washington, Seattle. Regular Kno-Draft Air Diffusers with pendant light fixture adaptations are used to achieve design simplicity and assure an uncluttered ceiling.

Kno-Draft Air Diffusers also offer the advantage of complete adjustability *after* installation. This assures *uniform temperature without drafts* throughout the conditioned area, and saves considerable preliminary slide-rule figuring.

There are Kno-Draft round, square and slotted units to meet all architectural and engineering requirements—the industry's most complete line of engineered air diffusers. Attach coupon to your letterhead and mail today for full information. Connor Engineering Corporation, Danbury, Connecticut.

Connor Engineering Corp., Dept. J-66, Danbury, Conn.

Please send data on Kno-Draft Air Diffusers. I am particularly interested in: ☐ round ☐ square ☐ slotted ☐ light fixture adaptability ☐ high pressure systems.

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Company_____

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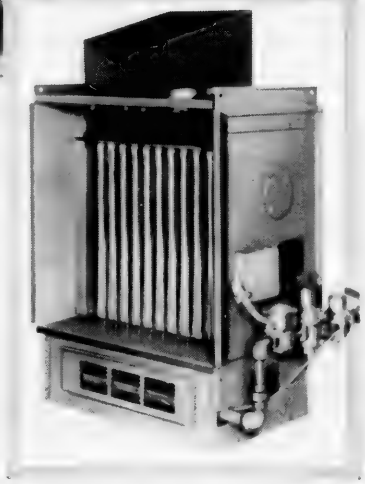
kno·draft®
adjustable air diffusers

Young, Richardson, Carleton & Detlie, Architects and Engineers

Here's the ideal furnace for use with packaged air conditioners



It's *Modine* STAINLESS STEEL Gas-Fired Duct Furnace

RUST and corrosion-resistant stainless steel burners and heat exchangers make the Modine Gas-fired Duct Furnace especially suitable for use with cooling coils or packaged air conditioning units. Equally adaptable to straight space heating and drying applications. Lightweight units are easier, less expensive to ship and install.

Only Modine offers all these advantages

Fast, uniform heat is assured by seam-welded, gas-tight tubes, direct-fired . . . large, self-cleaning ports.

Convenient controls are mounted on side of unit for easy access, regardless of furnace location.

Removable burner unit for easy inspection, service.

Five sizes — from 88,000 - 213,000 Btu/hr input . . . all AGA approved.

Wide application—gas-fired duct furnaces are ideal for residential, commercial, institutional buildings . . . industrial and agricultural drying, processing and ventilating.

For complete information, see the Modine representative listed in your classified phone book, or write Modine Mfg. Co., 1511 DeKoven Ave., Racine, Wis., for Bulletin 855.

Modine GAS-FIRED STAINLESS STEEL DUCT FURNACES

D-1311

NEW CATALOGS

(*Continued from page* 154)

Use the prepaid postcard on page 105 for securing your copies of catalogs described in this department.

AXIAL FAN CATALOG—A 36-page illustrated catalog (Bulletin B-1013) describing Series 203 axial fans for ventilation, process air supply, and process air recirculation applications is available from American Blower Corp., Detroit, Mich. The catalog describes and illustrates tube-axial and vaneaxial flow principles and explains the various arrangements possible with axial fans. ..... **Item 83**

FOLDER ON WELDING—Information of interest and value to those associated with the fabrication and installation of process piping is contained in a folder (TDC-162A) on welding issued by Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa. The folder provides information on the welding characteristics of both austenitic and ferritic types of stainless steels and briefly describes various welding methods and techniques. ..... **Item 84**

SPECIFICATION SHEETS — Specification sheets giving dimensions and operating data on both vertical and horizontal models of central station, cabinet type, air conditioning units are issued by Worthington Corp., Harrison, N. J. Bulletin No. C-1100-S106P is on the vertical model; Bulletin No. C-1100-S107P for the vertical and horizontal model; and Bulletin No. C-1100-S108P for horizontal models. ..... **Item 85**

THERMOSTAT BULLETIN—Revised Bulletin No. 1000B, issued by Sarco Co., Inc., New York, N. Y., describes electric room thermostats for factories and institutions. Also featured are immersion thermostats for hot water heating systems, unit heaters and alarm circuits and surface thermostats for control of unit heaters. ..... **Item 86**

AIR DIFFUSER CATALOG—A 16-page catalog on strip air diffusers is issued by Air Devices, Inc., New York, N. Y. The catalog illustrates typical installations and gives engineering characteristics and suggested applications of the diffusers in addition to performance data. ..... **Item 87**

VIBRATION CONTROL GUIDE—An illustrated publication (K6A) entitled The Plant Engineers' Guide to Machinery Mounting, Vibration and Noise Control is published by The Korfund Co., Inc., New York, N. Y. The bulletin shows by means of case histories how vibration problems are being solved by using isolation media like springs, cork, and rubber..... **Item 88**

BASEBOARD RADIATION CATALOG—A 12-page catalog covering Custom and Pre-Fab baseboard radiation is available from The Rittling Corp., Buffalo, N. Y. Illustrated, the catalog gives capacities, ratings, specifications, dimensions and engineering data. ..... **Item 89**

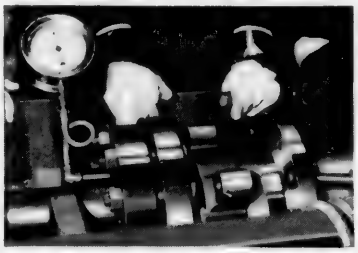
(*Continued on page* 158)

ADSCO

PISTON-RING EXPANSION JOINTS

can be unpacked at full operating pressure

PROOF FROM THE PITTSBURGH TESTING LABORATORY



All packing has been removed. There is no trace of steam in the empty stuffing box, even though steam in the line is at 240 lbs. with 700 F total temperature.

● For simple maintenance, a new ring of packing can be added to an ADSCO Piston-Ring Slip-Type Expansion Joint, but when the old packing has been allowed to become scored, it should be removed and replaced with fresh packing. The ADSCO Piston-Ring Joint is the only joint in the world in which this can be accomplished without shutting off line pressure. With the vent valve open, piston rings hold the line pressure while the joint is being serviced as in photograph at left.

Other features: The slip is continuously guided at its extreme ends throughout its entire length of travel. Primary and secondary limit stops prevent the slip from being pulled out of the body. Openings in the external guide provide easy access to the packing gland for adjustment. The external guide is built in halves to reduce the size of manholes required in underground construction.

These ADSCO Piston-Ring Joints are available in both single and double types, in full range of sizes, with 4", 8", and 12" traverse per slip, and for temperatures to 800 F and higher.

● *Write for Bulletin 56-20.*

AMERICAN DISTRICT STEAM DIVISION
ADSCO INDUSTRIES, INC.
20 MILBURN ST. BUFFALO 12, N. Y.

Airsan Viro Crimp
HIGH VELOCITY AIR FILTERS

VIRO CRIMP MEDIA
has special Hemmed Edges for strength and safe, easy handling. No cuts! No Scratches! No Filter surface damage.

AFI MEMBER AIR FILTER INSTITUTE

- MAXIMUM EFFICIENCY (288 — 510 FPM)
- MINIMUM RESISTANCE
- NO DIRECT AIR PASSAGE
- LARGE DUST HOLDING CAPACITY

Also Available . . .
Low Velocity and Grease Filters.
Write for catalogs and prices.

Air Filter Corporation
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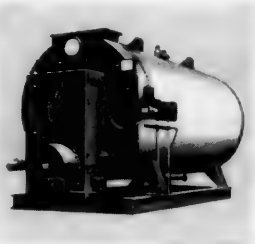
Canadian Representative
DOUGLAS ENGINEERING CO., LTD., MONTREAL

A few distributorships available.
Write for details!

Wherever Continental Automatic Boilers are installed, people are saving money.

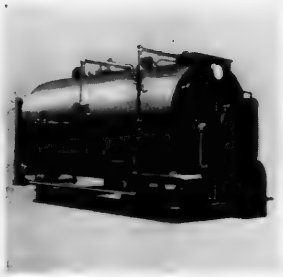


Front and right side view of one of four 400 hp Continental Automatic Boilers ready for shipment to four cement products processing plants.

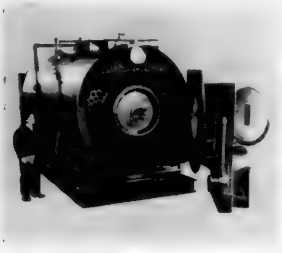
With a

Continental BOILER

You, too, can...

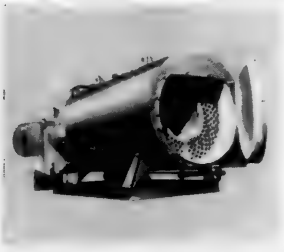


Front and left side view of same 400 hp unit — note simplicity of design.



View with front doors open showing gas burner assembly.

View with rear door open — showing furnace, return tubes and refractory-lined rear door.



SAVE ON INITIAL COST!

. . . for Continental Boilers are frequently *lowest* in purchase cost, yet feature highest quality workmanship, materials and controls.

SAVE FUEL COSTS!

. . . for Continental Radiant Flame Heating meets or beats other methods for fast, economical heat. And its unique "Spinning Gas Technique" affords maximum heat transfer and efficiency.

SAVE TIME, LABOR, MAINTENANCE!

. . . through Continental Boiler's simple, functional design that affords quick access to furnace and return tubes, easy cleaning and inspection, brief shut-down.

SAVE REPAIR AND REPLACEMENT COSTS!

Long, trouble-free service is made possible because all return tubes do equal work, affording balanced water circulation and uniform expansion.

Sizes 20 to 500 hp; 15 to 250 psi. Gas, oil or combination fired. Write for literature, and let B.E. bid on the next boiler you need.

Continental AUTOMATIC BOILERS

BOILER ENGINEERING and Supply Company, Inc.

7 Manavon St. • Phoenixville, Pa. • Phone 5832

NEW CATALOGS

(Continued from page 156)

Use the prepaid postcard on page 105 for securing your copies of catalogs described in this department.

CLASS III FAN CATALOG—A catalog (Bulletin DS-348C) covering Class III fans designed for high velocity air conditioning systems is issued by The Trane Co., La Crosse, Wis. The fans are cataloged in single and double width arrangements, in sizes 18 through 73. ----------**Item 90**

COMPRESSOR SERVICE BOOKLET — A parts list and service instruction booklet has been released by Copeland Refrigeration Corp., Sidney, Ohio, covering its 4-cylinder, high-speed, belt-driven compressors. The illustrated service instructions cover the replacement of valve plates, seal assemblies and oil pumps. ----------**Item 91**

BASEBOARD BULLETIN—A 16-page sales bulletin is published by C. A. Dunham Co., Chicago, Ill. The booklet, No. 1231, contains photos, drawings and technical data on the company's baseboard and gives roughing-in-data, design and details of typical installations, capacities and procedures for selecting the desired baseboard systems. ----------**Item 92**

COOLING COIL CATALOG—Catalog DE-200, describing a line of direct expansion cooling coils is issued by Halstead & Mitchell, Pittsburgh, Pa. The catalog describes the construction of the coils, including tubing, casings, headers, refrigerant distribution, return bends, and valves of the coils. ----------**Item 93**

POWER TOOL CATALOG—A catalog of industrial portable power tools, listing more than one hundred models and accessories, with price schedules, is available from Skil Corp., Chicago, Ill. The catalog presents the many items of the line pictorially with photographs and in many cases with cutaways to show details of construction. ----------**Item 94**

STEAM GENERATOR CATALOG—A 12-page catalog (Bulletin 5511) on water tube steam generators is offered by the Titusville Iron Works Co., Titusville, Pa. Basic specifications, dimensions, and illustrations of the tube arrangement and gas passes are given in the catalog. ----------**Item 95**

HEAT DISTRIBUTION PROBLEMS—A 16-page bulletin disussing modern room heat distribution problems is published by Shaw-Perkins Mfg. Co., Pittsburgh, Pa. Its contents include descriptions and illustrations of proper radiator installation for churches, hospitals, schools, offices, homes, institutions, and commercial buildings. ----------**Item 96**

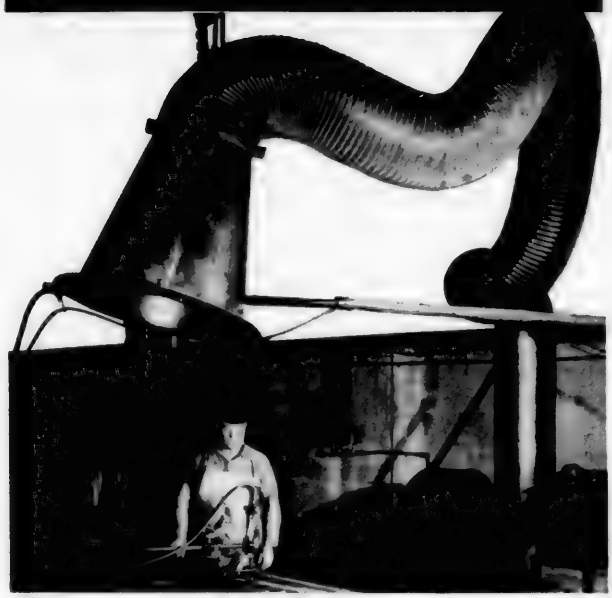
HEATING CONTROLS CATALOG—The publication of a brochure (Bulletin NR-26) for heating contractors and engineers is announced by International Register Co., Chicago, Ill. The 4-page folder describes the use of automatic time controls with oil burners, gas units, and stokers. Standard applications are listed with the type of time control required. A section devoted to wiring diagrams accompanies the suggested uses. ----------**Item 97**

(Concluded on page 160)

EXHAUST...

WHEN You Want It
WHERE You Want It

FOR EVERY INDUSTRIAL APPLICATION



with FLEXAUST® hose

In a large midwestern chemical plant, 12" I.D. Flexaust Hose is used to exhaust fumes and heat from a flame-cutting operation. The hood to which the Flexaust hose is attached is carried on a movable boom, putting the exhaust exactly where it is needed. Available in 1¼" to 36" I.D.

EASY TO INSTALL

• Unskilled labor can cut and install Flexaust duct quickly and easily. A set-up like this one can be easily installed and just as easily moved to meet changes of process or relocation of machines. It can be cut to any length, and is easily coupled to any other duct work.

HIGHLY FLEXIBLE

• No layout problems with Flexaust! Made of nylon or cotton base impregnated with age-resistant Neoprene compound and reinforced with spiral wire, it will not kink or flatten. It maintains its cross-section even on sharp bends. As it has excellent lengthwise compressability, it is easy to transport and store.

LONG LASTING

• Flexaust is highly resistant to corrosion, moisture, chemical deterioration and flexing fatigue. Its bonded, double ply, double overlap construction makes it fully air-tight for pressure, suction or gravity operations. It outlasts other types of ducts in handling abrasive dusts as in grinding, materials handling, etc.

You can use Flexaust for fume exhaust, for dust or chip collection, for ventilation, for handling of bulky materials. In every application it proves its economy in first cost and simplicity of installation . . . its efficiency in its performance and adaptability to all types of jobs. Also available, retractable type Portovent duct.

Write today for bulletins giving complete data on flow characteristics, installation procedure, sizes, fittings and accessories.

THE FLEXAUST COMPANY

Rept. HV-6, 100 Park Avenue, New York 17, N. Y.
Formerly American Ventilating Hose Co.
Stocks are available from coast to coast

Slot

STRIPLINE DIFFUSERS by AGIAIR®

Slot

Type F

Type S

STRIPLINE combines the best features of both slots and efficient air diffusers to provide equalized air flow throughout its entire length.

STRIPLINE slot diffusers are slenderly designed, inconspicuous, practical and versatile. These slot diffusers can be located in walls, ceilings, coves, moulds, window reveals and stools or almost anywhere to suit interior design.

Type H

Write for complete Stripline Catalog.

AIR DEVICES INC. • 185 MADISON AVENUE • NEW YORK 16, N. Y. • AIR DIFFUSERS • FILTERS • EXHAUSTERS

Which of these
NEW PETROMETER
Liquid Depth Gauges

best suits your installation?

You can obtain new Petrometer Series 1400 Remote Reading Tank Gauges in 4 Models to suit almost every industrial installation. All gauges operate on the sound principle of hydrostatic pressure . . . no moving parts or intricate mechanisms to cause failure through wear, corrosion or friction. Large, vertical scale gives accurate, easy-to-see readings.

Gauges can be installed on tanks above or below the ground and up to ¼ of a mile away.

CHOOSE FROM THESE 4 MODELS

MODEL 1400 A

Equipped with aerating valve for semi-automatic purging of the transmission line. Purging line attaches to compressed air line.

MODEL 1400 B

Equipped with Bubbler as well as aerating valve. Transparent Bubbler provides a constant visual check on aeration. Used with compressed air source.

MODEL 1400 F

Equipped with Flowmeter and aerating valve. Actual rate of flow of air for purging can be preset and indicated on the Flowmeter. Requires compressed air supply.

MODEL 1400 M

For use where compressed air source is unavailable. Equipped with Manual Air Compressor and Aerating Valve.

Petrometer Gauges can be obtained in multiple units incorporated on a single panel and mounting plate to meet your specifications. High-level — low-level alarms also available.

For complete information, send for Bulletin 6004.

Petrometer CORPORATION

43-22 TENTH STREET, LONG ISLAND CITY 1, N.Y.

NEW CATALOGS

(*Concluded from page* 158)

FASTENING TOOL BOOKLETS — Two booklets, showing different ways in which a fastening tool can be used, are offered by Ramset Fastening System, Olin Mathieson Chemical Corp., Cleveland, Ohio. One booklet shows how the tool can be used for plant maintenance. The second tells how it is used for lead lining. ------**Item 98**

PUMP BULLETIN—Type S condensate pump and a complete line of vacuum and condensate pumps are described in 28-page bulletin, No. 1465, offered by Sarco Co., Inc., New York, N. Y. The reader will appreciate the large cut away illustrations, the pump selection guide and the installation diagrams. ----------**Item 99**

TUBING BULLETIN—Production and design engineers are offered a 4-page folder (TB-362) published by Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa. The bulletin tells how electric-resistance-welded carbon steel mechanical tubing solved engineering problems and simplified production. ----------**Item 100**

BOILER CATALOG—Thirteen sizes of Pacific 800 series wet back Scotch type boilers are described in Catalog AP-294, issued by Pacific Steel Boiler Division, Johnstown, Pa. A 4-color cutaway drawing in the catalog depicts the component parts of the boiler. Ratings, capacities, recommended burner sizes, dimensions and engineering data are given. --**Item 101**

CONDENSED VALVE CATALOG — An 8-page catalog (P&H-56) of Cash-Acme automatic valves for the plumbing and heating industry includes twenty-two models not previously announced and is available from A. W. Cash Valve Mfg. Corp., Decatur, Ill. Tables showing pipe sizes, listed ratings, and shipping weights, plus other important facts concerning the valves, are given. ----------**Item 102**

NYLON FITTING IS DESCRIBED — A 4-page bulletin describing a lightweight Nylon fitting, which is impervious to most acids and alkalies, is published by Jaco Mfg. Co., Cleveland, Ohio. Specifications and illustrations of the fitting are given and its use explained. ----------**Item 103**

AIR CONDITIONING BULLETINS—A series of four bulletins is issued by Peerless of America, Inc., Chicago, Ill., giving engineering data on air-cooled condensers (Bulletin No. NW155), cooling and heating units (Bulletin No. CX155), water coils (Bulletin ACW 155), and 4-row air conditioning coils (Bulletin No. AC 155-1). ----------**Item 104**

CARBON DIOXIDE ANALYZERS — A 4-page catalog (56-553-1) issued by Hays Corp., Michigan City, Ind., contains photos of different types of chemically operated carbon dioxide analyzers and recorders. Descriptions of the operation and sampling system are accompanied by drawings of the analyzer. ----------**Item 105**

Use the prepaid postcard on page 105 for securing your copies of catalogs described in this department.

With this new, sectional design Niagara condenser you avoid the many troubles due to faulty condensing and get at all times the full capacity your refrigerating plant should afford.

You benefit from extra saving in upkeep labor and expense. The casing of this new condenser is made of sections each separately removable, giving you access to all parts for easy inspection to head off dirt and corrosion, to clean the coils easily from either side.

You benefit from greater efficiency in condensing. A simpler method of using evaporative cooling improves heat transfer. You benefit from Niagara features that remove super-heat before condensing and keep the system purged of oil. You save 95% of the cooling water cost.

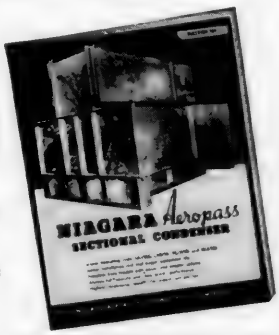
You benefit from a low first cost, lower freight cost and less expense in erection.

Capacity range is from 90 to 240 tons. Write for Niagara Bulletin 131. Find out how your plant can save expense this season.

NIAGARA BLOWER COMPANY

Dept. H. V., 405 Lexington Avenue
NEW YORK 17, N. Y.

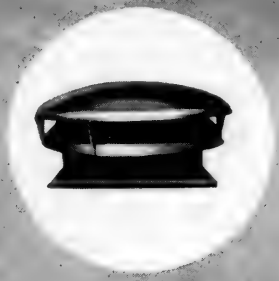
District Engineers in Principal Cities



NIAGARA *Over 40 Years' Service in Industrial Air Engineering*

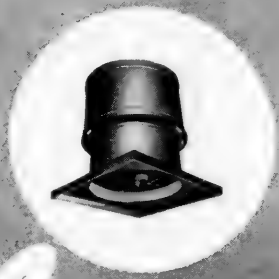
ACCEPTED *Allen* **ROOF VENTILATION**

Whatever your ventilating needs, be sure to see how Allen equipment can meet your requirements efficiently and economically.



NEW "I-LINE" for EYE APPEAL

The new "I-Line" provides an attractive low contour, assuring maximum capacity or efficiency with the minimum over-all height.

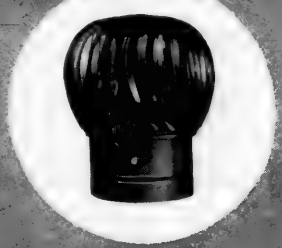


POWERFUL "VD" for HIGH VELOCITY

By moving a large volume of air at high velocity, this Vertical Discharge fan keeps fumes from sifting back into building.

Allen

. . . is prepared to investigate ventilating problems and plan systems for the efficient removal of heat, fumes, vapor or dust.



WIND-DRIVEN TURBINES

Three types of Allen turbines take full advantage of the economy of natural air movement.

EXHAUST FANS

Remote drive Staxauster is designed to handle corrosive fumes, and/or high temperature air.

THE ALLEN LINE

Write today for catalog that gives specifications and performance data on these and other units in the Allen ventilator line.

Allen

ALLEN COOLER & VENTILATOR, INC.
ROCHESTER, MICH.

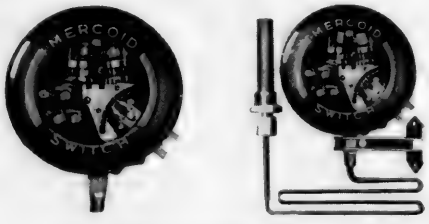
Roof Ventilators for Every Commercial and Industrial Need
REPRESENTATIVES IN PRINCIPAL CITIES

DO YOU HAVE A TWO-STAGE PRESSURE OR TEMPERATURE CONTROL PROBLEM

MERCOID® HAS THE SOLUTION

Mercoid DA-400 Series Controls are dual purpose controls (available for pressure or temperature) incorporating a single element operating two separate independently adjustable Mercoid magnetic mercury switches. Circuit arrangements can be supplied for various operations, a few examples are:

- ***Close one alarm circuit at high setting and a separate circuit at low setting. Both circuits remain open between the high and low operating points of the two switches.***
- ***As an electrical interlock to open one circuit on a rise above and the second circuit on a drop below the set operating point.***
- ***To provide two-stage control by opening one circuit on a rise and a second circuit on a further rise.***



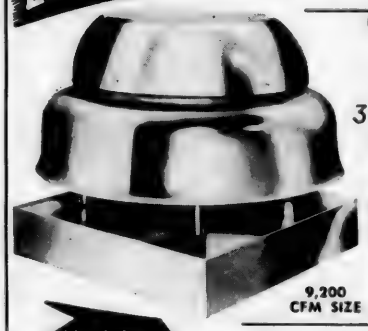
Pressure types **available in 17 different operating ranges from 0-30" vac. to 300-2500 psi.** ***Temperature types*** **available in 11 operating ranges from -30-60°F. to 370-530°F.**

All types are equipped with external adjustments and visible calibrated dial.

WRITE FOR BULLETIN CA-PT

THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.

Low Silhouette **COOK Direct Drive Ventilators**



Model R 300 to 2100 CFM

Model BV 300 to 9,200 CFM

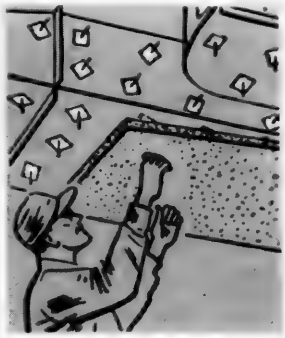
Lightweight • Spun Aluminum • Rubber Mounting • Easy Installation • Non-overloading Blower Wheel (Aluminum)

AVAILABLE IN LOW RPM

Cook direct drive ventilators are now available in speeds as low as 490 rpm. You can install a Cook direct drive unit where normally only belt drives are used. Low tip speeds for quiet operation. Light starting torque with aluminum blower wheel. Only 6" high roof curb required. All aluminum construction saves hundreds of pounds roof load on large models. Also available are wall ventilators, and belt drive centrifugal ventilators. Write for Catalog HV. In Canada write to H. F. Clarke Ltd., 244 W. Broadway, Vancouver, B. C.

COOK VENTILATORS
LORENZ COOK COMPANY
Berea, Ohio

These models will be shown in the 1956 SWEET'S FILE

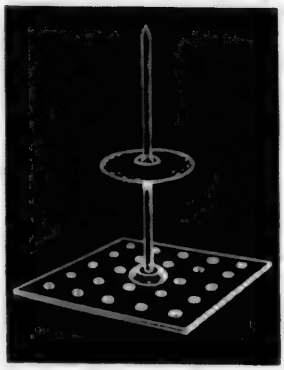


USE MIRACLE SURFACE ANCHORS with Miracle Anchor Adhesive TO SPEED INSTALLATION OF INSULATION

No faster way to bond fiber glass, batts and mineral wool to ducts, walls and ceilings. You eliminate drilling, welding, expansion bolts. Miracle Surface Anchors provide firm support, with lockwasher designed to hold insulation firmly in place to eliminate any delamination of insulation. You cut time and costs. And, there's no damage to surface in event installation is ever removed.

FREE: Valuable Anchor Technical Bulletin, complete with details and specification data. Yours without obligation.

MIRACLE SURFACE ANCHORS are manufactured by
DEVICES, INC.
a division of
MIRACLE ADHESIVES CORP.
214 E. 53 St., New York 22, N. Y.



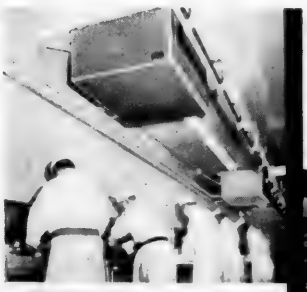
REFRIGERATING ANATOMY

of a super SUPER MARKET!

Panorama #3 Market, Reseda, California

by DRAYER-HANSON

Installing Contractor: National Refrigeration Sales of Los Angeles, Inc.



2 SPOTAIRES — Meat Cutting & Packaging Rooms

4 HOT SHOTS — Meat Storage Room

2 SPASAVERS — Dairy Cooler

Had the Full Story, yet, on product-produce storage and refrigeration?

D-H equipment has solved "tough nut" refrigeration problems — since 1910.

Request bulletins, XX-1

1 FLOCOLD — Beverage Cooler

1 HOT SHOT — Ice Cream Freezer Room

PLUS . . . 10 more units, individually installed.

drayer-hanson

SINCE 1910

3301 Medford Street • Los Angeles 63, California

(Division of National-U.S. Radiator Corporation)

ARE ALL YOUR EGGS IN ONE BASKET?

Paracoil IS THE MAJOR NEW SOURCE OF SUPPLY

FOR

OIL AND WATER

COOLERS

IMPORTANT O.E.M.'s HAVE SWITCHED TO

Paracoil TYPE "P" EXCHANGERS

Dependence on only one source of supply may mean a stoppage of your own production. You owe it to yourself to investigate the Paracoil oil and water coolers!

Compare these features:

Designed to minimize thermal change stresses, to provide seal between shell and tube fluids, to facilitate inspection of tube sheets and tube ends, the cleaning of tubes and the testing of tubes.

Built With Standard Components for diversified heat exchanger applications to high standards of design and construction.

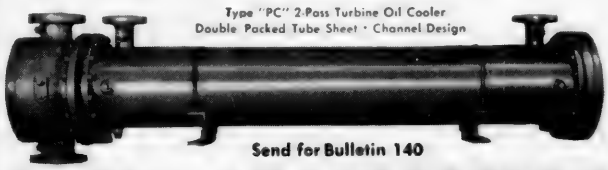
As Oil Coolers — for bearing oil, turbine oil, hydraulic systems oil, transformer oil, gear oil, seal oil, etc.

As Water Coolers—for internal combustion engine and compressor jacket water, electrolyte solutions, brine solutions, boiler blow-down, condensate, etc.

As Air or Gas Coolers—for inter- and after-coolers on air compressor installations and miscellaneous gas cooling applications.

For Stationary and Marine Service.

Type "PC" 2-Pass Turbine Oil Cooler
Double Packed Tube Sheet • Channel Design



Send for Bulletin 140

DAVIS ENGINEERING CORPORATION

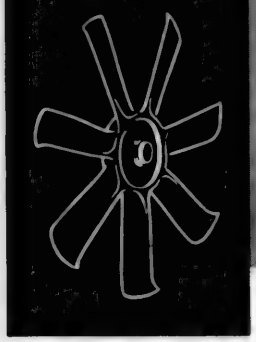
30 Rockefeller Plaza • New York 20, New York

1064 East Grand Street • Elizabeth 4, New Jersey

more air - less horsepower . . . .

sp-7

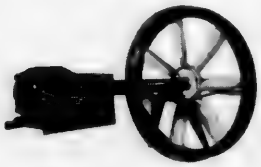
Aerovent
7-blade
semi-pressure
fans



Increased operating efficiency and economy without "special" equipment or costly modifications. The secret? It's the design of the new 7-blade "Macheta" Airfoil Propeller!

direct connected

Wider, heavier-sectioned blades, designed expressly to move *more* air at *slower* speeds, require *less* horsepower than conventional types; permit use of *smaller, more economical,* standard-construction motors.

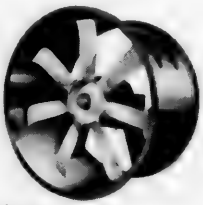


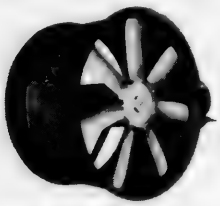
extended shaft

Especially effective against resistances in the 1½" to 4" static pressure range, "SP-7" Fans are adequately powered to prevent motor overload.

direct driven duct

Standard Aerovent assemblies, with "industry's most efficient air-moving surface," now offer the advantage of lower initial cost, reduced operating expense and quieter operation.



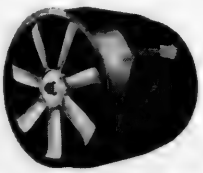


belt-driven duct

Available in sizes 14" to 60" in a wide range of speeds and capacities, these units are supplied for all types of installations and for all operating characteristics.

"bi-flo" duct

Consult your Aerovent representative or write the factory direct for detailed performance data and specific ratings on standard assemblies for every industrial ventilating or air-moving requirement.



All Aerovent Fans are rated in accordance with the Standard Test Code and U.S.D.C. Comm. Std. CS178-51

Aerovent FAN COMPANY, INC.

ASH and BRANDT STS. PIQUA, OHIO

Unbreakable, Roll-Up...

Dwyer

SLACK TUBE MANOMETERS

Resilient Spring Steel Scale holds vinyl plastic tube rigid for easy set-up and use . . . yet whole instrument rolls up to pocket or tool kit size.

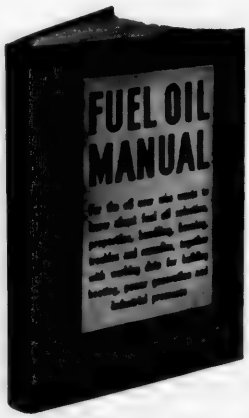
Read pressure, vacuum or differential with no parallax error . . . full 2-inch sliding zero adjustment.

Complete with plastic ⅛" pipe thread connections, carrying plugs, and adapters. Standard ranges from 8" to 120" water or mercury.

● *Write today for literature and prices*

F. W. DWYER MFG. CO.

P. O. BOX 373-N MICHIGAN CITY, INDIANA



Here is a book that will give you a comprehensive picture of the characteristics and uses of every type and grade of fuel oil. The author explains the meaning of each oil property, and shows how this information is applied to the selection, handling and burning of fuel oil. Impurities and how they effect combustion are described fully, and a special chapter describes fuel oil additives and how they are used. Another chapter lists troubles which may be encountered in using fuel oils, and shows the correct remedy to apply in each case. Technical language is avoided wherever possible, and all terms are fully explained.

160 Pages **$3.50** 34 Tables

In Canada or overseas, $4.20

THE INDUSTRIAL PRESS

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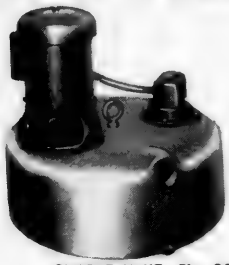

SINGLE UNIT—Fig. 302A
10 Gal. Receiver for Single Units
Diameter 21"
Hgt. of Return above floor 6⅞"

Capacities 500 to 10,000 sq. ft. E.D.R.

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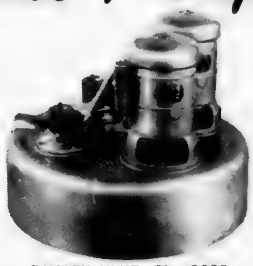

DUPLEX UNIT—Fig. 303B
15 Gal. Receiver for Single or Duplex Units
Diameter 25½"
Hgt. of Return above floor 7¾₁₆"

TVC SELECTION TABLE

Unit Number	Max. Sq. Ft. E.D.R.	Discharge Pressure At Pump	G.P.M. From Radiation	Cap. of Pump	H.P. of Motor	Return Inlet	Pump Discharge	Dia. of Receiver	Height of Unit
TVC 13	500	20 lbs.	.25	1.0 GPM	1/4	2"	1"	21"	21"
TVC 19	750	20 lbs.	.38	1.5 GPM	1/4	2"	1"	21"	21"
TVC 23	1000	20 lbs.	.5	1.5 GPM	1/4	2"	1"	21"	21"
TVC 29	2000	20 lbs.	1.0	3.0 GPM	1/4	2"	1"	21"	21"
TVC 35	4000	20 lbs.	2.0	6.0 GPM	1/4	2"	1"	21"	21"
TVC 41	6000	20 lbs.	3.0	9.0 GPM	1/2	2"	1"	21"	23½"
TVC 47	8000	20 lbs.	4.0	12.0 GPM	1/2	2"	1"	25½"	23½"
TVC 52	10000	20 lbs.	5.0	15.0 GPM	3/4	2"	1"	25½"	27½"

See Bulletin TVC-300-C for Full Specifications

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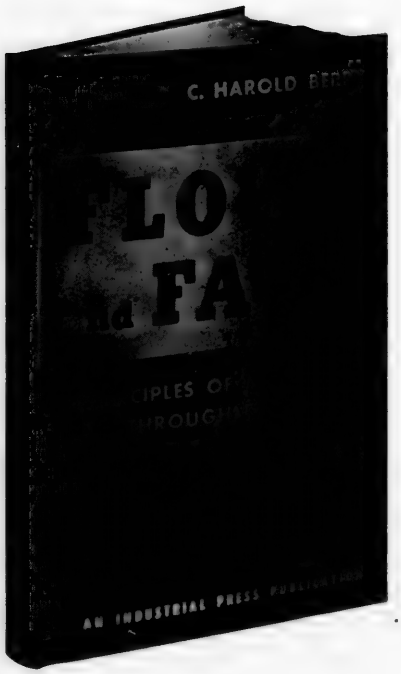

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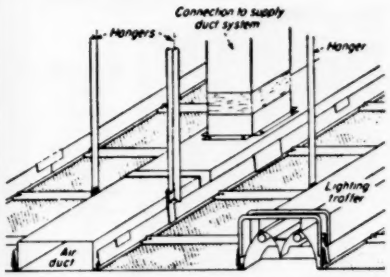

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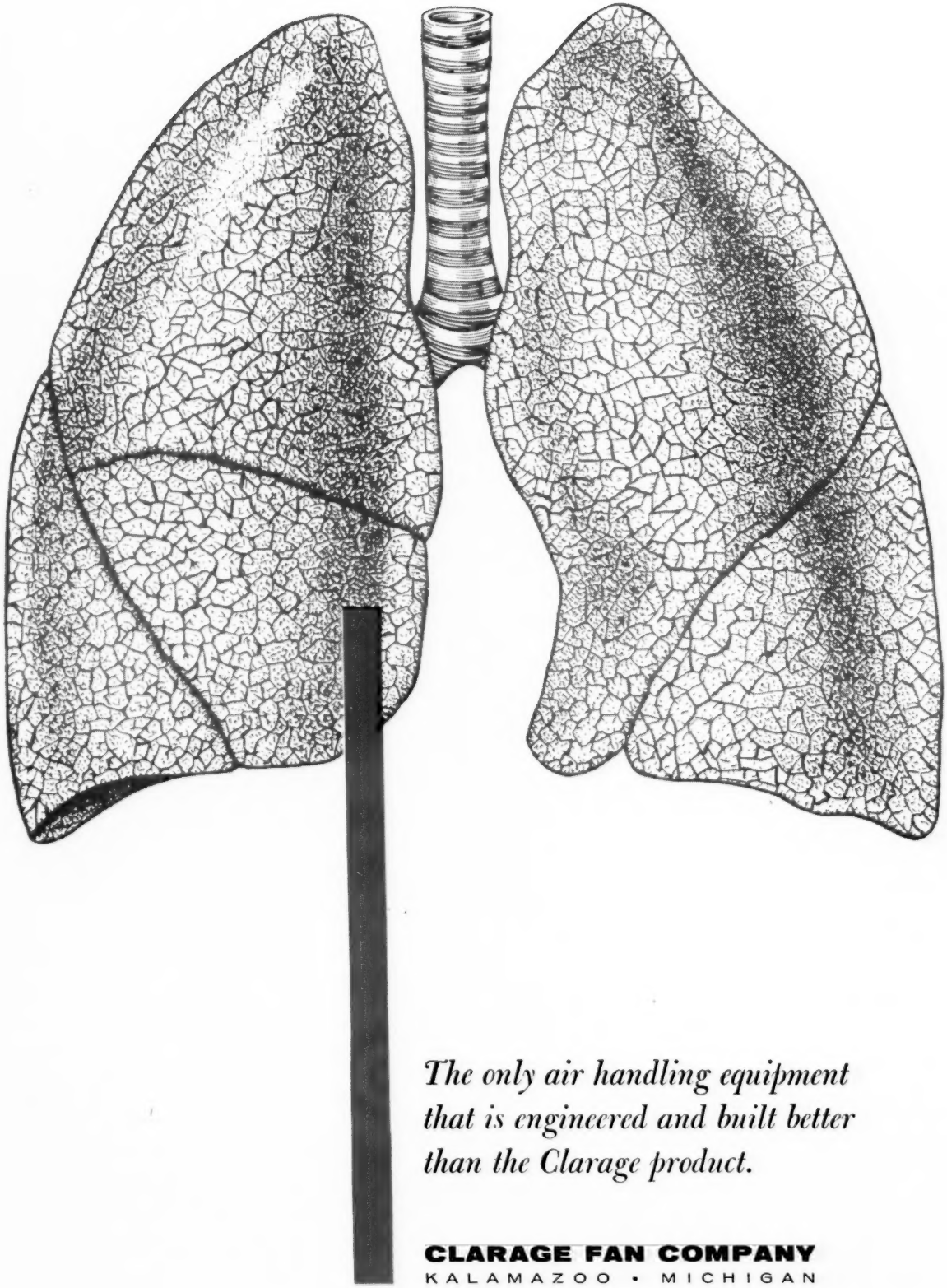

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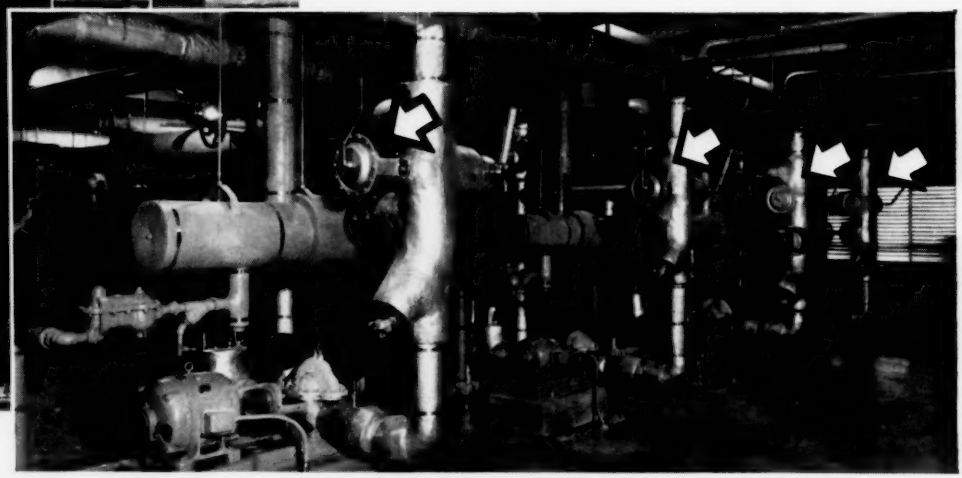

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